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TOWARD FURTHER EXPANSION OF FERROUS METALLURGY IN THE RUSSIAN FEDERATION (RSFSR)

N. I. Sheftel'

State Planning Office of the RSFSR

The metallurgists of the Russian Federation have entered a decisive stage in the practical fulfillment of the historic resolutions of the Twenty-first Conference and the June Plenum of the Central Committee of the Communist Party of the Soviet Union on further advancement of engineering. Measures are being developed for the further intensification of metallurgical production, the more extensive introduction of automation and mechanization, the adoption of new types of rolled products and the increased production of rolled products which are in short supply as well as the introduction of improved processes.

To increase the output of the mining industry it is intended that work on the Korshunov and Kachkanar ore concentration combines, the Lebedin and Teisk mines be speeded-up, which will increase the amount of ore mined in the Republic by almost 1.6 times in the next few years compared with 1959. The introduction of these measures will considerably increase the amount of ore mined by the open cast method using highly productive machinery, thus improving the working conditions and the labor productivity.

At the coke ovens of the Chelyabinsk, Kemerovsk and Svedlovsk National Economy Councils it is intended to carry out experiment work and to introduce on an industrial scale new methods for processing coals and for coking: selective crushing of coals, ramming the charge, production of formed coke.

In the RSFSR more than 95% of all iron is smelted in automated blast furnaces. Blast furnace workers of the Russian Federation hold the record for the most efficient use of blast furnaces in the USSR. This has been the result of improved charge quality, increasing the pressure and temperature of the blast together with automation of the blast furnace process. The average coefficient of utilization of useful volume at the RSFSR plants in 1958 was 0.72, for the 5 months of 1959 it was 0.71 and at a number of plants 0.61-0.66.

Considerable improvements can be obtained in blast furnace production by intensifying the process, by greater enrichment of the iron ores, by introducing high productivity, high power blast furnaces at a number of plants, and by the use of natural gas and oxygen.

The USSR holds the leading position with regard to the automation of blast furnace scale cars. With the automatic control systems developed at the Kuznetsk and Nizhne-Tagilsk Combines scale cars can be completely automatically controlled. The first plant in the USSR to introduce automated feed of the charge into the blast furnace was the Magnitogorsk Metallurgical Combine. Much work has been planned on the further automation of blast furnace production including controlling the process.

Among the measures introduced in steel smelting will be the extensive use of natural gas in combination with oxygen. This will lead to considerable intensification of the steel smelting process, will improve the designs of open-hearth furnaces and reduce capital costs for plant construction.

It is intended to use computers to extend the complex automation of thermal control in open-hearth furnaces. Experience with this type of automation in the large furnace of the Nizhne-Tagilsk Steel Combine showed that it is possible to obtain 14.5-16 tons of steel from 1 m^2 of the furnace hearth per day compared with 9-10 tons taken at the present time

The Magnitogorsk Combine and the Cherepovetsk Plant were the first in the Russian Federation to smelt steel in large-capacity open-hearth furnaces.

A considerable increase is expected in the production of converter metal. Large capacity converters have been installed at the Kemerovsk, Sverdlovsk and Lipetsk plants. An advantage of the oxygen process in large-capacity converters is the larger productivity of the equipment compared with open-hearth shops together with a smaller number of units and reduction in capital costs. The productivity of a 90-100 ton converter is 1.75-2 times higher than that of a 500-ton open-hearth furnace.

Experimental work is being carried out at the Novotula Plant on the continuous casting of transformer steel from small capacity ladles. The introduction at the Novolipetsk Plants of high power electrical furnaces and machines for continuous steel casting is linked with the continuous casting of transformer steel. Continuous casting will also be introduced in other plants, initially at the Gor'kov and Stalingrad Councils of National Economy.

Further expansion is envisaged in the vacuum smelting of steel. The vacuum smelting of molten steel in the ladle permits considerable reductions in the gas saturation and hence, improvements in quality. Experience at a number of plants has shown that the vacuum smelting of transformer steel reduces the specific losses; in some grades there is a reduction in the number of hair cracks in the finished rolled material. The Chelyabinsk and Moscow Councils of National Economy will introduce vacuum electrical furnaces for the production of special purpose alloys.

The use of rolled material of balanced steel is an important measure in increasing the amount of useful metal and improving the steel quality. A considerable increase is planned in the production of low allow and balanced steel. The use of low alloy rolled material which has high strength will permit considerable reductions in the amount of metal used in engineering and construction work, and will therefore reduce the weight of machines.

In this connection greater use should be made of the naturally alloyed steels of the Orsko-Khalilov Steel Combine. It is suggested that the introduction of rolling mills be speeded up at this combine and meanwhile that the Orsko-Khalilov ingots be used at other plants.

There is a considerable demand for stainless sheet steel, particularly for chemical plants. To meet this demand the production of this particular material will be increased at the Chelyabinsk and Stalingrad plants. To do this new plants will be built and there will be more capacity for slab milling, heat treatment and pickling of the rolled steel in existing shops.

Measures are being developed to speed up the construction of a cold rolling mill at the Novolipetsk Steel Plant. This mill will produce coiled and sheet steel after double decarburization annealing of the cold rolled transformer steel strip in tower furnaces (in a hydrogen atmosphere) in intermediate and final sizes. This type of heat treatment gives considerable reductions in electrical power losses in the steel and consequently, the electrical industry is able to manufacture highly efficient transformers and electrical machines which have high powers coupled with small dimensions and weight. The production of cold rolled material at the Novolipetsk Plant will permit considerable reductions in the production of hot rolled transformer steel.

Increases are envisaged in the production of sheet steel. Whereas in 1958, the proportion of sheet steel was 26.4% of the total production, toward the end of the 7-year period (with a considerable increase in total production) it will be almost 33%. The Cherepovetsk Plant and the Orsko-Khalilov Combine will produce fine gauge steel for the manufacture of electrically welded pipes for water mains, gas and petroleum pipes. At the Magnitogorsk Combine a high productivity 2500 mill is being built to roll sheet steel of thickness 2 mm and above with widths of up to 2300 mm. The introduction of these sheet mills in 1959-1960 will increase the capacity of this type of production by 7 million tons of sheet per year.

In order to economize in metal there will be more production of economical profiles of hot rolled steels, including lighter designs. After 1960 only light designs of beams and girders will be manufactured; not only will this lead to economies in metal but will also simplify and accelerate constructional work and the manufacture of machines.

There will be an increase in the production of new types of rolled, pipe and nail products.

At the Novosibirsk Plant, steel conveyor belts will be manufactured. The use of these belts in many branches of production will reduce the consumption of rubber and increase the fields of application of material transport by conveyor belts. In order to economize in ferrous metals and stainless steels, at the Pervo-Urals Pipe Factory there will be an increase in the production of dual layer pipes, lined with plastics. Work will be initiated to increase the production of bimetal sheet with a coated layer of nonferrous metals and stainless steel of various grades.

There will be further increases in the industrial production of steel-aluminum wire which can be used to replace copper.

There will be extensive development in the production of high tensile wire of up to 8 mm diameter for reinforced concrete. This will permit the large scale introduction of pre-stressed reinforced concrete for construction work.

Much more work will be carried out on the extensive introduction of heat treatment at steel plants. At a number of plants, there will be increased production of sheet steel hardened by heat treatment. As a result of the higher strength and improved steel quality there will be reduction in the weight and improvements in the reliability of operation of machines. In a number of cases it will be possible to use carbon steel instead of alloy steel and to improve the properties of rimming and desulfurized steels so that they can be used instead of killed, and open-hearth steel.

The Plenum of the Central Committee of the Communist Party of the Soviet Union has indicated that the mechanization of rolled production is one of the most important problems in the complex mechanization of laborious processes in steel working. Whereas, the level of mechanization is fairly high in the basic units in modern rolling mills, the auxiliary sections, including finishing, maintenance, packing and labelling of the rolled production, employ more than 40-50% of all the workers in the rolling mills.

The plans of new rolling pipe and nail mills will be inspected to ensure that they have been correctly chosen in the light of the present stage of developments. Concrete measures will be developed to mechanize and automate existing mills.

The level of automation and mechanization of rolled production will be considerably increased. This will follow the introduction of complex mechanization and automation of rolling mills and finishing units at the Kuznetsk, Magnitogorsk and Nizhne-Tagilsk Combines. This was decided by the Council of Ministers of the USSR for the Development of Complex Mechanization and Automation of Industrial Processes. These plants will have machines for flame slab milling and flow line billeting, machines for mechanized emery cleaning of rolled material, machines for packing rolled material and other equipment. These large steel combines will be converted into experimental centers for mechanization and automation so that the experience gained can be applied in other steel plants.

The punctual completion of these measures will ensure a considerable improvement in steel making, will improve its level of efficiency and will lead to the successful solution of problems put before steel workers by the Twenty-first Conference of the Party and the June Plenum of the Central Committee of the Communist Party of the Soviet Union.

FUTURE DEVELOPMENTS IN BLAST FURNACE PRODUCTION

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The tremendous plan for the development of the national economy of the USSR from 1959 to 1965, adopted by the Twenty-first Conference of the Communist Party of the Soviet Union envisages an increase in iron smelting to 65-70 million tons per year. Many requirements must be met in order to fulfill this plan. The building of new blast furnaces will be speeded up, the capacity of existing furnaces will be increased during general overhauls.

It is of prime importance to further increase the output of blast furnaces. Despite the fact that Soviet blast furnaces give more iron than comparable furnaces in other countries, we still have unused reserves.

One very important way for improving blast furnace production in the USSR is to radically improve the preparation of raw materials for smelting. It is extremely important to speed up the development of iron ore enrichment which is currently very slow. Concentrates must be prepared containing more than 60% of iron.

As well as equipping new ore enrichment plants, it is essential to put into production enrichment methods which are not yet used for iron ores—enrichment in heavy mediums, flotation. Extensive use must be made of the magnetizing roasting of hematite ores.

The development of iron ore enrichment is extremely important not only for the considerable extension of the ore reserves, and the use of poor ores, but also for reducing the amount of slag produced. At the present time the amount of slag produced in Soviet blast furnaces, especially in the south, is too high; it should be reduced to 500 kg per 1 ton of iron or less.

It is extremely important to have greater uniformity in the chemical composition of iron ores. When working with uniform ore, there are no longer intensive fluctuations in the heating of the hearth and in the slag composition. Efficient averaging of the ores, starting at the mines, should reduce the deviations from the mean contents of iron and silicon to ± 0.5%.

A very important way of increasing furnace output is sorting the charge materials with regard to coarseness with separate charging of fractions into the blast furnace. This considerably improves the gas permeability of the column of charge materials and improves the distribution of the gas stream, reducing the segregation of materials. It is essential that the iron ore part of the charge should consist of two grades of coarseness—approximately 15-35 mm and 35-50 mm; the finer fractions should be screened off and sintered.

To fulfill this requirement it will be necessary to increase the content of sinter in Soviet blast furnaces to approximately 90% on the average, which requires a considerable increase in the capacity of sintering plants. New sintering machines should be constructed with an increased sintering area (100-200 m^2).

As well as increasing the production of sinter it is essential to increase its basicity up to a level which completely excludes limestone from the charge of the blast furnaces and in the second place it is essential to improve the strength of the sinter.

Bearing in mind that the size of fluxed sinter is less at the present time than that of unfluxed sinter, it is essential to improve the sintering process in order to obtain fluxed sinter of sufficiently high mechanical strength.

Some countries are currently producing spherical pellets with roughly the same dimensions. However, the use of unfluxed pellets (as is the practice in the USA) gives barely favorable results. It is therefore essential to develope a technique for producing fluxed pellets. It is also very important to produce a partially reduced material (in the form of pellets or briquets).

The considerable increase in iron smelting planned for the 7 year period requires a considerable increase in the production of coke and a corresponding increase in the mining of coking coals. Since the reserves of these coals are much less than the total reserves of regular coal, difficulties may arise in supplying coking coals to industry. Greater use should be made of natural gas in blast furnace production, thereby reducing the specific consumption of coke and the production of formed fuel should be organized using the method developed by the Corresponding Member of the Academy of Sciences of the Ukrainian SSR, L. M. Sapozhnikov, together with the collective of the Soviet coke chemists. The Sapozhnikov method can be used to obtain strong metallurgical fuel from some gas coals which are extensively distributed in nature but are not used at present to any great extent in metallurgy.

Experimental batches of fluxed fuel prepared in a pilot plant have high mechanical strength, which would indicate that this fuel could be used successfully in blast furnaces. In this way it would be possible not only to overcome the shortage of coking coals but also provide a considerable improvement in the quality of metallurgical fuel. In the present Seven-Year Plan, however, formed fuel will be manu-

factured in comparatively small amounts and the basic fuel for blast furnaces will still be coke

As before, it is extremely important to improve the quality of coke. There is no doubt that the coke strength can be improved even when the charge for coking contains a certain amount of weakly sintering coals. There is still work to be done in the efficient preparation of coals for coking. Much can be done in the way of improving the enrichment of the coals used in the coking in order to reduce the ash content and in some cases, the sulfur content. Improving the crushing, mixing, and storing of the coal and controlling its oxidation will improve the quality of the charge used in coking. The following measures are not yet being applied to their fullest extent: efficient charging, improved design of coke ovens, selection of optimum rate of increase in temperature in the coking charge and the optimum period of coking, and the use of ramming in some cases.

As well as improving the preparation of raw materials for the smelting it is essential to introduce improved smelting methods. These improved methods consist of increasing the gas pressure in the working space of the blast furnace, introducing desulfurization outside of the blast furnace, combined blast and also in perfecting methods for controlling the blast furnace process.

Many furnaces in the Soviet Union have not yet converted to high gas pressure working. Of the furnaces operating with this system, only at a few of them is the pressure at the throat higher than 1.0 atm and in a very few cases the pressure is 1.5 atm (the maximum pressure used, first tried in the USSR). However, there is no reason to think that this pressure is the optimum. At the present time, it is not possible to establish theoretically the optimum limit for increasing the gas pressures in the working space; this limit can only be established in practice.

The main advantage to be gained from increasing the gas pressure in the working space of the blast furnace is in reducing the gas speed in the column of charge materials and removing conditions which would cause the formation of "channels". As a result, it is possible to increase the amount of blast fed to the furnace and to intensify the smelting.

Theoretical considerations and experimental data indicate that increased pressure leads to an increase in the rate of reduction of iron oxides by carbon monoxide, hydrogen and also by mixtures of them. However, a noticeable increase in rate of reduction is only obtained on increasing the pressure above 2.0 atm. It may be assumed that on increasing the gas pressure in the working space to this level, advantages will be obtained not only due to the reduction in gas speed but also to the acceleration of the indirect reduction processes.

Further increase in gas pressure is limited at the present time by the following facts:

1) it is uncertain what changes might arise in the blast furnace process on increasing the pressure above 1.5 atm;

2) the fact that some blast furnaces are not equipped for operation at a pressure of 1.5 atm and above;

3) the problem of using the mechanical energy of the blast furnace gas is not yet resolved.

It is essential to investigate the effect of increased pressure on the fusion process, to find out whether the combustion process at the tuyeres changes, the reduction processes, slag formation, the descent of the charge, etc.

Many years experience of operating blast furnaces with increased pressure have shown that there is a considerable reduction in the life of the charging equipment with the new system of operation. A design should be developed for a more durable charging apparatus. Certain other designs should should also be improved—tuyere hose, atmosphere valves, etc.

When the gas pressure in the throat is increased above 1.5 atm, the energy expended in feeding the blast increases considerably. A gas turbine should be installed at the point where the gases expand in order to make use of the mechanical energy of the compressed gas.

Although external desulfurization is used in many foreign countries, it has not yet found widespread application in the USSR although Soviet blast furnace engineers often work with a charge containing much sulfur. In our opinion, it is of prime importance to introduce external desulfurization of the iron in Soviet blast furnaces. This measure will considerably reduce the coke consumption, will increase the furnace productivity, and the steel smelting shops can be supplied with iron having a lower sulfur content.

The main problem to be solved in introducing external desulfurization in the USSR is the selection of the desulfurization method, the desulfurization reagent, and also establishing the optimum slag composition and blast furnace operation with acid slags with subsequent external desulfurization.

Conditions in the Soviet Union would require the use of lime as the basic desulfurization agent, using it in rotating drums (the Kalling process) or in ladles where the lime powder will be blown in by means of special sprays. It would also be possible to pass a stream of molten iron through a layer of coke which is covered with lime.

Industrial tests should be made of I. P. Semik's method for desulfurizing iron with molten blast furnace slag. In this method the desulfurization takes place in a special unit where the iron reacts with slag in the same way as in the blast furnace. To restore the desulfurizing capacity of the spent slag it is blasted with air or oxygen; the sulfur in the slag is almost completely oxidized and is removed with the gases

It may prove desirable to desulfurize molten iron with metallic magnesium. In this connection, experimental work in the Soviet Union for some time past has yielded promising results. The possibility should also be borne in mind of using soda as a desulfurizing agent. It can be used quite successfully if a special apparatus is built in which the soda will be used with maximum efficiency and also harmful gases will be removed to ensure complete safety of operation for the workers.

The use of external desulfurization makes it possible to smelt iron with low basicity slags, which facilitates forcing of the blast furnace process, reduces the consumption of

limestone and the yield of slag; finally, there is a reduction in the coke consumption and an increase in the blast furnace productivity.

The use of combined blast, i.e., a blast which has various gaseous additions as well as atmospheric air (oxygen, steam, reducing agents and other gases) can be a means for increasing the intensity of smelting and reducing the specific consumption of coke.

At the present time, oxygen-enriched blast is used very little both in the USSR and abroad. Increase in the oxygen concentration in the blast by 4-6% causes tightening of the process and hanging. To prevent this the blast should be humidified, when it is not possible to increase its heating to a temperature at which the heat expended on decomposing the steam will be compensated. Under these conditions, oxygen enrichment of the blast leads to an increase in the coke consumption or to its retention at the previous level. In both cases the cost of the iron increases since the oxygen enriched blast costs more than a regular blast. This method of operation is, therefore, economically unacceptable even in spite of the considerable increase in blast furnace productivity resulting from the increase in fusion intensity.

The use of oxygen enriched blast when smelting special irons—ferromanganese and ferrosilicon—means that not only is it possible to considerably increase the productivity but also to reduce the fuel consumption. However, the production of these irons is very small in comparison with the total smelting of iron and the use of oxygen enriched blast only for smelting special irons does not solve the problem of using oxygen in blast furnace production.

Until recently, many metallurgists in the USSR had been rather skeptical with regard to the extensive use of oxygen enriched blast in blast furnace production. This attitude, however, has been shown to be wrong.

Steam is added to the blast in order to increase the smelting intensity, which occurs due to a certain increase in oxygen concentration in the blast, and mainly (as shown by I. P. Semik) as a result of reduction in the maximum temperature at the combustion centers. This leads to a considerable reduction in the amount of volatilizable slag-forming materials, mainly SiO. The process is also favorably affected by increase in the hydrogen concentration in the blast furnace gas. To compensate for the heat used to decompose the steam, with artificial humidification of the blast it is essential to considerably increase the heating of the blast (by about 9° for an additional 1 g of moisture introduced into 1 m^3 of blast).

Artificial humidification of the blast has played an important part in increasing the smelting intensity in Soviet blast furnaces. At the present time, however, this measure is losing its value due to the possibility of blasting methane-containing gases into the blast furnace hearth.

When these gases are blasted into the hearth, as is the case with blast humidification, the maximum temperatures at the combustion centers are reduced, which creates favorable conditions for forcing the blast furnace process. In this case, however, heat is not expended on decomposing the steam, as is the case when steam is blown in. Steam is formed in the combustion of methane (in this case heat is evolved) and then it decomposes, absorbing the same amount of heat. In this way, the amount of heat remains unchanged and the temperature is distributed across the section of the hearth, which means that the maximum temperature is reduced at the combustion centers.

It has been shown experimentally that blasting natural gas can lead to considerable reductions in the specific consumption of coke. This is partially due to the carbon of the methane burning to carbon monoxide but mainly it is due to the reduction in the degree of direct reduction, explained by the active reduction of hydrogen in improving the furnace process and increasing the heating of the blast.

When methane-containing gases are blasted in, there is an increase in the quantity of gases formed at the tuyere for a unit of coke consumed. This limits the possibility of increasing the amount of blast and, consequently, increasing the blast furnace productivity. The addition of methane-containing gases to the atmospheric blast should therefore be considered only as a means of considerably reducing the specific coke consumption and not as a means of increasing productivity.

When methane-containing gases are added to an oxygen enriched blast, apart from reducing the coke consumption there is a considerable increase in productivity. When the blast is enriched with oxygen, the volume of gases decreases, which means that the fusion intensity can be increased. The possibilities of using oxygen in blast furnace production are therefore widespread.

Blasting with methane-containing gas, apart from solving the oxygen problem, will also create favorable conditions for converting the blast furnace operation to higher blast temperature (1100-1200°).

To achieve high productivity in blast furnace operation and economic consumption of coke it is extremely important to literally control the process. The most important factor in this connection is in controlling the distribution of the gas streams.

Even highly skilled blast furnace workers are not always able to control the gas stream distribution as required. To make this possible, apart from improving the preparation of the raw materials for blast furnace smelting, the furnace should be fitted with more advanced control and measuring instruments and the charging equipment should be improved.

It is extremely important to build blast furnaces of 2000 m^3 volume and above. At the same time, work should be done on the selection of the optimum profile.

Technical progress is meaningless without extensive experimental testing of the new ideas. As well as checking the various dimensions of the profile, experimental tests should be made on the following ideas: the rotating distributor of the system developed by Professor N. S. Shchirenko, the housing of the large bell by I. L. Kordabnev, the charging equipment developed by I. M. Tsip, water cooling of furnace well, proposed by G. G. Oreshkin, controlling the gas streams according to the method of Professor A. N. Ramm.

Work should be carried out on the operation of blast furnaces with gas pressure exceeding 1.5 atm, the various methods of external desulfurization should be compared. Tests should be made on operation with an increased number of tuyeres, and the use of a second row of tuyeres in the boshes (feeding blast of varying composition and temperature through the hearth tuyeres and the bosh tuyeres), controlling the amount of blast at the various tuyeres, blowing lime into the tuyeres and other measures which might give advantages.

In the current Seven-Year Plan, Soviet blast furnace workers should not only fulfill the plan for producing iron, but should also firmly secure for our country technical superiority in all branches of blast furnace production. There is no doubt that this task will be fulfilled.

ROASTING PELLETS BY BURNING GAS IN A BED

I. I. Rovenskii

Mekhanobrchermet

Under industrial conditions, pellets are roasted abroad in shaft furnaces or on belt conveyor machines of the sintering type. As a rule, the transverse measurements of the shaft furnaces do not exceed 1.8 m. Further increase in this is not permissible since this causes considerable fluctuations in the temperature in the bed of pellets being roasted. Even in furnaces with 1.8 m transverse dimension, these fluctuations often cause local overheating in the furnace, which leads to caking of the material.

The roasting of fluxed pellets in a shaft furnace can introduce particular difficulties, since the narrow range of temperatures of softening and melting of the concentrate mixture with the flux requires the maintenance of strict temperature control. A small amount of overheating of the pellets causes strong fusion between them, thus considerably reducing the gas permeability of the bed.

Under conditions obtaining in the USSR, where all blast furnaces operate with fluxed sinter, the problem of producing fluxed products is a very real one. This can be achieved much more simply on belt conveyor machines than in shaft furnaces. Pellets can either be roasted on a fire grate by burning solid fuel rolled on to the surface of the pellets or by heating the bed with the products of combustion of a gas, burnt over the bed or by burning a gas in the bed itself.

The first method has been studied in greater detail and received extensive application abroad. The pellets obtained by this method have satisfactory hardness, but have a high FeO content (16-18%) and are difficultly reducible.

The second method, developed by the firm of Lurgi, can have any desired atmosphere in the pellet bed (oxidizing, reducing or inert) and consequently, products of any required quality can be obtained. If high calorie gas is used for this roasting (experiments at the Mekhanobrchermet used a mixture of propane and butane with calorific value 25,000 kcal/m^3) or liquid fuel, it is possible to organize the combustion with a large excess of air and to provide an oxidizing atmosphere, which is essential for obtaining thoroughly oxidized and readily reducible pellets. In our experiments, the amount of free oxygen in the exit gases reached 7-8% and the content of FeO in the pellets 1.6-3.6% The reducibility of the pellets obtained was approximately 1½ times that of the product obtained by the first method.

A drawback of the method is the high consumption of fuel since during roasting it is necessary to heat the whole bed of pellets simultaneously whereas, when working with the first method the zone of combustion, as is the case in sintering, moves from the top to the bottom, having a comparatively small thickness.

It would therefore seem desirable to burn the gas in such a way that the combustion occurred in a narrow bed of pellets, which would move from the top to the bottom. This can be achieved by having a high rate of flow of the gas-air mixture from the opening of the burner.

The pellets were roasted* in a steel container of height 450 mm and diameter 210 mm, lined on the outside with

*N. N. Berezhnoi took part in the work. In the development of this roasting method, use was made of the principle of gaseous sintering proposed by F. M. Bazanov and V. V. Konovalov and developed under the direction of A. N. Pokhvisnev.

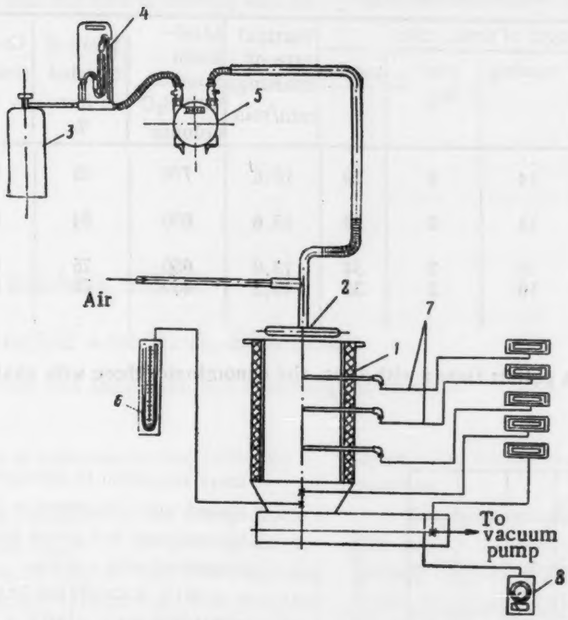

Fig. 1. Apparatus for roasting pellets in a bed: 1) container; 2) burner; 3) gas cylinder; 4) flow meter; 5) gas meter; 6) vacuum meter; 7) thermocouples; 8) flow meter for exit gas.

fireclay powder and asbestos sheet (total thickness of lining 25 mm).

A multijet tubular gas burner was installed over the container and gas was fed to it from cylinders and air from an air blower. The apparatus was fitted with the necessary control and measuring instruments. The apparatus is shown in Fig. 1. The combustion products were drawn off by a vacuum pump with a water cooling ring.

A 400 mm bed of pellets was loaded into the container. Before roasting they weredried for 3-5 min, the burner being placed at a height of 150-200 mm above the bed, so that the tongues of flame did not touch the surface of the moist pellets and did not cause them to decrepitate. After the drying, the burner was placed about 50 mm above the bed. The upper bed of pellets was then heated to the roasting temperature (1200-1300°). The true temperature was measured by placing a thermocouple junction in the center of the pellets.

When the upper thermocouple read 800-900° the air supply to the burner was increased, thus causing an increase in the rate of flow of the gas-air mixture from the burner openings. When the rate of flow approached 40 m/sec, the flame "opened out" from the burner and the combustion was transferred directly into the pellet bed. The roasting proceeded with surface combustion of the gas in the narrow bed of pellets, the combustion zone moving from the top to the bottom.

The air for the combustion (apart from that which entered the burner) was drawn between the pipes of the burner under the action of the vacuum.

The feed of gas was stopped when the temperature under the container began to fall. After the gas feed was stopped, the pellets were cooled to 800° in the bottom bed. The pellet sizes were 15-25 mm.

In the equipment, unfluxed pellets and also pellets fluxed to a basicity of 0.7, 0.85 and 1 were roasted.

The coefficient of consumption of air per minute was calculated from the amount of exit gas and the gas flow. The roasted pellets were tested for crushing on a hand press and were tested for strength on a Rubin drum. The results for these tests are given in the table.

The production of unfluxed pellets. Pellets obtained on a plate granulator were loaded without any additions into the container and the burner above them was lit. At the start of the experiment, the total coefficient of air consumption was 1.3-1.5 (allowing for the air drawn between the burner pipes). The rate of flow of the gaseous mixture from the burner was then 10-15 m/sec. The upper bed of pellets was dried and heated with this system. The air flow to the burner and vacuum under the fire grate was then increased. The coefficient of consumption of air increased sharply and in the course of 2-3 min it reached 2.0-2.5. The flame "opened out" from the burner.

With steady combustion in the bed, the weight of gases passing through the layer decreased due to the increase in volume of the combustion products as a result of thermal expansion. The vacuum under the fire grate then increased and the amount of air drawn in was reduced and the coefficient of consumption of air was reduced to 1.5-1.6.

Data for the Roasting of Pellets by Combustion of Gas in the Bed

Basicity of Pellets	Flow of gas, liters	Length of time, min				Vertical rate of roasting, mm/min	Maximum vacuum, mm H_2O column	Yield of fraction +5 mm, %	Crushing strength, kg	Drum sample, %	Content of FeO,%
		Drying & heating up to tearing of flame	roasting	cooling	total						
—	710	12	14	3	29	15.6	770	88	170	19	3.3
0.7	550*/720	13	13	3	29	15.6	600	84	170	12	3.3
0.85	770	12	19	3	34	13.0	650	75	160	12	3.0
1.0	750	14	16	3	33	13.5	450	70	170	17	2.5

***The numerator contains pellets fluxed with lime, the denominator those with chalk.**

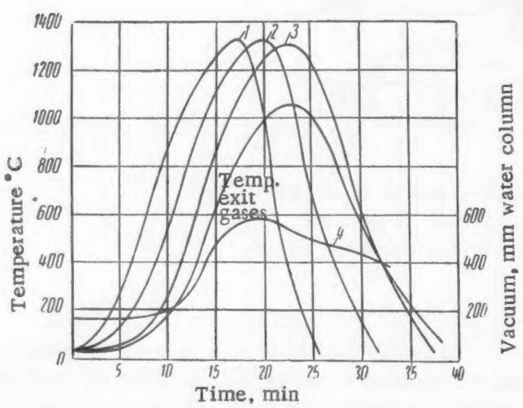

Fig. 2. Temperature and vacuum during roasting of unfluxed pellets in a bed: 1), 2) and 3) are the temperatures at distances of 300, 200 and 100 mm from the fire grates respectively; 4) vacuum.

The change in temperatures in the pellet bed and the vacuum is given in Fig. 2, from which it can be seen that the thermocouples in the lower beds had a somewhat lower reading than in the upper bed, for the maximum temperature. With a constant coefficient of consumption of air the reverse should be the case, since the gas-air mixture is heated when it passes into the lower levels. The lower temperatures of the bottom part of the container are explained by the necessity for increasing the removal of gases and, consequently, the amount of air drawn in to accelerate the movement of a combustion zone in the pellet bed.

The drum test for the pellets produced was 19.0%, the crushing strength 170 kg. The yield of pellets + 5 mm after throwing from a height of 2 m was 88%.

The production of fluxed pellets. During the drying and heating of the fluxed pellets, their upper bed decrepitated strongly due to removal of the hydrate moisture (in the case where lime was used) or CO_2 (in the case where limestone or chalk were used). Pellets fluxed with lime were more subjected to decrepitation during heating than those fluxed with limestone or chalk. This is due to the lower temperature and lower heat of decomposition of $Ca(OH)_2$ compared with $CaCO_3$.

With accelerated heating of unfluxed pellets, only the upper bed decrepitated a little, and during heating of fluxed pellets (even slowly) especially with a basicity of one, a two to three pellet deep layer decrepitated. More fines were obtained than during the roasting of unfluxed pellets, thereby disturbing the uniform distribution of gas across the section of the container; at some points the pellets fused into one piece and in some places where the gas-air mixture had not penetrated very well, the pellets were not roasted at all.

The maximum vacuum during the roasting of fluxed pellets is often lower than during the roasting of unfluxed pellets, since with a high vacuum, when the permeability of the layer is small, there is no uniform roasting across the section of the container and the experiments failed. The drum test of the fluxed pellets was better than in the case of unfluxed pellets but the yield of fraction + 5 mm after throwing was much less and decreased with increase in basicity.

The roasting of one ton of raw pellets by combustion of gas in the bed requires approximately the same amount of heat as in roasting with solid fuel and about 1.5-2 times less than when roasting with gas above the bed. The quality of the product obtained is better than when roasting with solid fuel.

The experiments confirmed the possibility of roasting by burning gas in the pellet bed. With this type of roasting, the upper bed of pellets is often less efficiently calcined than the deeper beds. It is therefore advisable to use a combined process of roasting: at first heating the upper layer of pellets by burning gas above the layer in special hearths, and then roasting the low-lying pellet beds by burning gas in the bed. This provides slow drying and heating and at the same time roasting of the low-lying beds will proceed with less consumption of fuel than in the roasting by burning the gas above the layer.

It is intended to introduce this process of gas roasting in the pilot plant at YuGOK. The drying of the whole bed

and roasting of the upper part will be effected by burning gas in hearths over a pellet bed and further roasting will be by means of multijet tubular burners, developed by the "Mekhanobrchermet" Institute.

REPLACING THE SMALL BELL

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"Zaporozhstal' " Plant and Dnepropetrovsk Metallurgical Institute

Wear in the small bell is indicated by the following signs:

1. Large losses of small fractions of the charge from the reception hopper and the hopper of the rotating distributor when the charge is poured from the skip (the balancing valves work on a supplementary system, i.e., with the space between the bells filled).

2. Sparking of the gases in the reception hopper when the hot sinter is fed to the small bell. The hot gases attack the flexible rubber hoses of the lubrication system for the balancing device.

3. Slow balancing of pressure in the space between the bells. This can cause the bar of the large bell to bend and force it to open.

The bell is finally rejected after it has been inspected through the inspection doors of the gas seal. Characteristic wear of the small bell is shown in Fig. 1.

Before the furnace is stopped to replace the small bell, the new bell, intended for the equipment, is assembled on a dummy bar. If the bell does not fit the dummy, it is adapted to fit the bar (this is usually done in the machine shop). The bolts for fastening the bell should enter the hole freely and the nuts should be turned by hand.

As soon as the maintenance workers are ready the furnace is stopped. If the last tapping of iron does not coincide with the start of the working day for the maintenance workers, the tapping cycle is changed. Immediately after the finish of tapping, the furnace is converted to normal pressure and the gas pipes of the semipure gas of the balancing valves of the large bell are disconnected. At the same time the bolts on the assembly door of the gas seal are cut (3 bolts are cut in a row and each 4th is left).

In our opinion the assembly door is best fastened with 4-6 wedges (like the inspection doors on the gas seal). The wedge connection requires much less time in assembly and dismantling than a bolt connection, the more so since after 6-8 months of operation the bolts on the assembly door cannot be removed (due to corrosion) and they must be cut.

The furnace is loaded to a level of 0.5-0.75 mm, retaining the loading system which was used before the shutdown. The temperature of the throat should be as low as possible.

Gradually lowering the pressure and amount of blast, the furnace is converted to slow operation and is then completely stopped. After the large bell has worked for the last time, the steam supply to the space between the bells is stopped, all remaining bolts on the assembly door are cut and it is opened together with all inspection doors.

Formerly the furnace was stopped and both bells were opened and the gas in the space between them was burnt, after which the large bell was closed and covered with ore and slag, and allowed to cool to 80-100°, and then taken for overhaul. With this method the overhaul took up to 16 hr and the throat temperature fell rapidly, sometimes as low as 600-800°, which led to deformation of the components of the charging device (especially of the large bell and its housing) and loss in tightness of their joint.

Since 1955 at the "Zaporozhstal' " Plant, following the suggestion of B. L. Tavrog, the small bells are replaced without burning the gas in the throat. After the furnace is converted to slow running, steam is fed under the large bell and, having stopped the furnace, excess pressure of 50-60 mm water column is maintained under the large bell. The pressure is controlled by throttling or opening the atmospheric valves.

Fig. 1. Characteristic wear of the small bell.

The sway-beam of the large bell is tied to the nearest girder and 2 skips of fine sintered ore are added to the large bell to seal all cracks and on top of the ore there are 3-5 skips of granulated slag. The small bell is then opened and the drives are disconnected for the winches of the bells, skip hoist, rotating distributor and other mechanisms which are being overhauled. At the same time, checks are made on the composition of the gas in the space between the bells and permission is then given to replace the small bell. With this type of shutdown, the temperature in the space between the bells is usually 70-80°. Cutting torches are used to cut a circle round the small bell up to the height of the internal cams (Fig. 2).

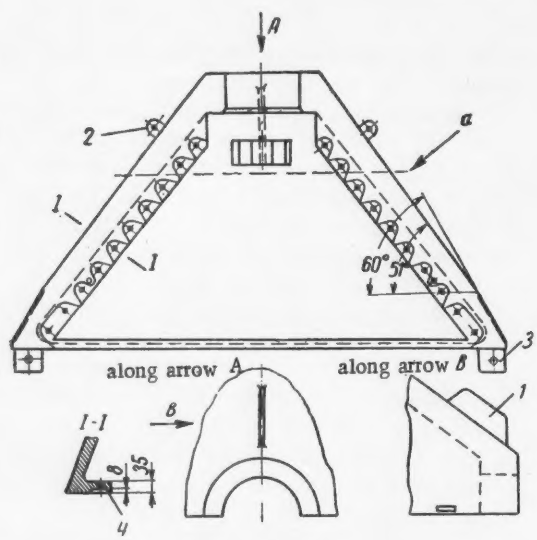

Fig. 2. Small bell: a) line of cut; 1), 2), 3) assembly "lugs"; 4) groove for cutting bolts.

After it falls the cone is cut up into 3 sections along verticals (see Fig. 1), the holes are cut through and a winch is used to remove the sections through the assembly door from the space between the bells on to the throat platform. The teeth of the lock of the lower protective ring are then cut and a half of the ring is discarded; a stop is welded at the free place on the bar of the small bell in order to prevent the protective rings of the small bell bar from descending when the second half of the lower ring is removed; after the second half of the ring is discarded the remaining upper bolts which had fastened the halves of the small bell are cut and the upper parts of it are discarded.

This operation lasts 90 min and the valuable bell is entirely lost whereas it could have been restored by closing the holes by melting. For this reason special grooves have been cut around the tie bolts in the contact surfaces of the halves of the small bell. This follows a suggestion by S.A. Reznichenko and allows the bolts to be cut with a cutting torch. When the bell is dismantled with this method, "lugs" are welded to it and each half is hung on the hook of the assembly winches. The control pins are then knocked out and the bolts are cut. The halves of the bell are then separated and lowered into the space between the bells and brought out on to the throat platform through the assembly door.

After the bell has been removed its seating position on the bar is carefully cleaned of ore and all holes are sealed by melting. When operating furnaces with a pressure under the throat of 0.8-1 atm with the space between the bells filled, extensive damage is often observed on the small bell bar due to the fact that gas passes into the gap between the bar and bell. To prevent this, the small bell is now welded to the bar during assembly; during overhauls the welded section is cut.

After the small bell is dismantled, its sway-beam is placed in the "closed" position, and on the bar of the large bell inside the space between the bells, a device is mounted for machining the contact surface of the hopper of the rotating distributor. The machining usually adds another 2-3 hr on to the time of overhaul. For this reason a suggestion of Reznichenko is now being used; the contact surfaces of the rotating distributor for the charge are made in the form of removable rings (Fig. 3). When the small bell is replaced, the bottom ring is cut along a line, split into two halves and removed from the bar of the large bell. The upper ring of the replacement bell is machined. With this design the contact surface of the hopper can be changed twice between replacements of the charging apparatus.

The worn contact ring is cut at the same time as the small bell is dismantled. At the same time the tie bolts

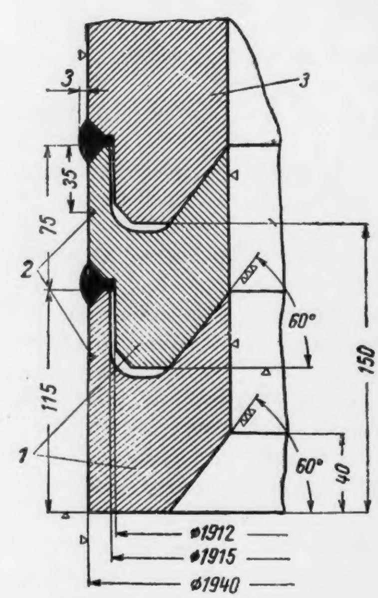

Fig. 3. Removable contact surfaces: 1) rings; 2) guide marks; 3) bottom part of hopper of distributor.

are tightened on the tie rods of the small bell bar suspensions at the height of the cut ring (75 mm) to prevent the position of the sway-beam changing when the small bell closes. The nuts and thread on the tie rods should be protected from corrosion and dust.

When the worn parts of the small bell are removed the halves of the new bell are brought into the space between the bells. The first half is connected by the "lug" 1 (see Fig. 2) and is lifted to the seating position, at the same time the position of the winch pulley block is changed, the second half of the bell is lifted by the "lug" 1 to the height of the seating position and both halves are fastened by bolts through the "lugs" 2 and 3. The bolts are fastened and the halves of the small bell are brought to within 10 mm, after which connecting bolts are inserted in the internal connecting flanges of the bell Before tightening it is essential to make sure there are no dents or dirt on the mating contact surfaces. When the clearance between the halves of the bell is 0.5-1 mm along the whole of the joint on both sides, the nuts of the tie bolts are slackened off by half a turn and the control pins are inserted. The bolts are then finally tightened and the joint is tested with a feeler gauge. The bell is then lowered 300 mm. At the same time the pulley block and tackle are removed, the "lugs" 1 and 2 are cut off, the assembly door is closed and the units are prepared for operation. The chart showing the replacement of a small bell is given in Fig. 4.

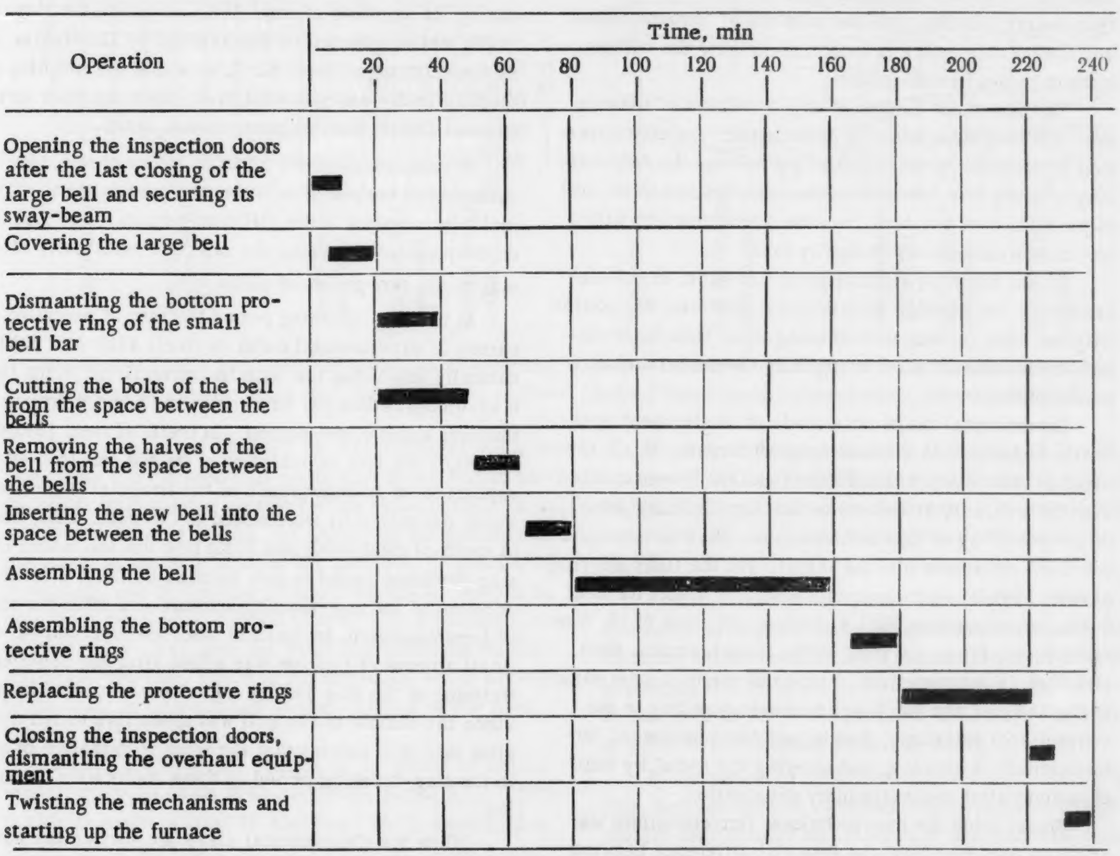

Fig. 4. Graph showing replacement of small bell.

THE USE OF FERROCHROMIUM SCRAP IN SMELTING CHROMIUM AND CHROMIUM-NICKEL STEELS

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N. I. Shirokov Siberian Metallurgical Institute

For alloying steel with chromium, in general, ferrochromium is introduced after the preliminary deoxidation of the metal. In this process, because of the comparatively high temperature at which ferrochromium melts (1470-1540°C) and because of the slow rate at which the metal dissolves chromium carbides, the metal is held for more than twenty minutes after the addition of ferrochromium and the holding period is longer, the higher the carbon content in the ferrochromium.

The important defects of such a method of alloying are: the long time taken in deoxidation; the contamination of the steel by nonmetallic inclusions; the impossibility of using fine ferrochromium; and the rise in the cost of production of the steel, because ferrochromium with a low carbon content is principally used.

At the Kuznetsk Metallurgical Combine, in collaboration with the Siberian Metallurgical Institute, the possibility has been investigated of using scrap from high-carbon ferrochromium Khr6 in smelting chromium and chromium-nickel steels.

Experimental melts were made in single-spout open-hearth furnaces with chrome-magnesite roofs. In all, ten melts of steel 40Kh, 20Kh, 18KhGT and NL-2 were smelted with the addition, at the end of the slag-finishing period, of 1500-2430 kg of fine ferrochromium Khr6 to introduce 0.5-0.9% chromium into the metal. For the final alloying of steel 18KhGT ferrochromium Khr1 was used; for steel 20Kh, ferrochromium Khr1 and Khr4; for steel NL-2, ferrochromium Khr4; for steel 40Kh, ferrochromium Khr4 and Khr6. For comparison, a series of melts of steel 40Kh, 20Kh, 18KhGT and NL-2 was smelted according to the conventional technique, that is, without additions of ferrochromium in refining, and alloying the metal by ferrochromium after the preliminary deoxidation.

Since, using the new technique, ferrochromium was added in slag-finishing, the essential difference between the experimental and conventional melts was observed only in the refining and deoxidation periods.

Analysis of the average of the separate operations in experimental and conventional melts shows that the duration of all the operations in experimental melts was greater than in conventional melts, except for dephosphorization (the ore boil and removal of the slag) in smelting steel 18KhGT and the deoxidation in smelting steel 20Kh. Therefore, the total duration of refining (dephosphorization, finishing the slag, pure boil) in experimental melts was also found to be greater than in conventional melts by 19-47 minutes.

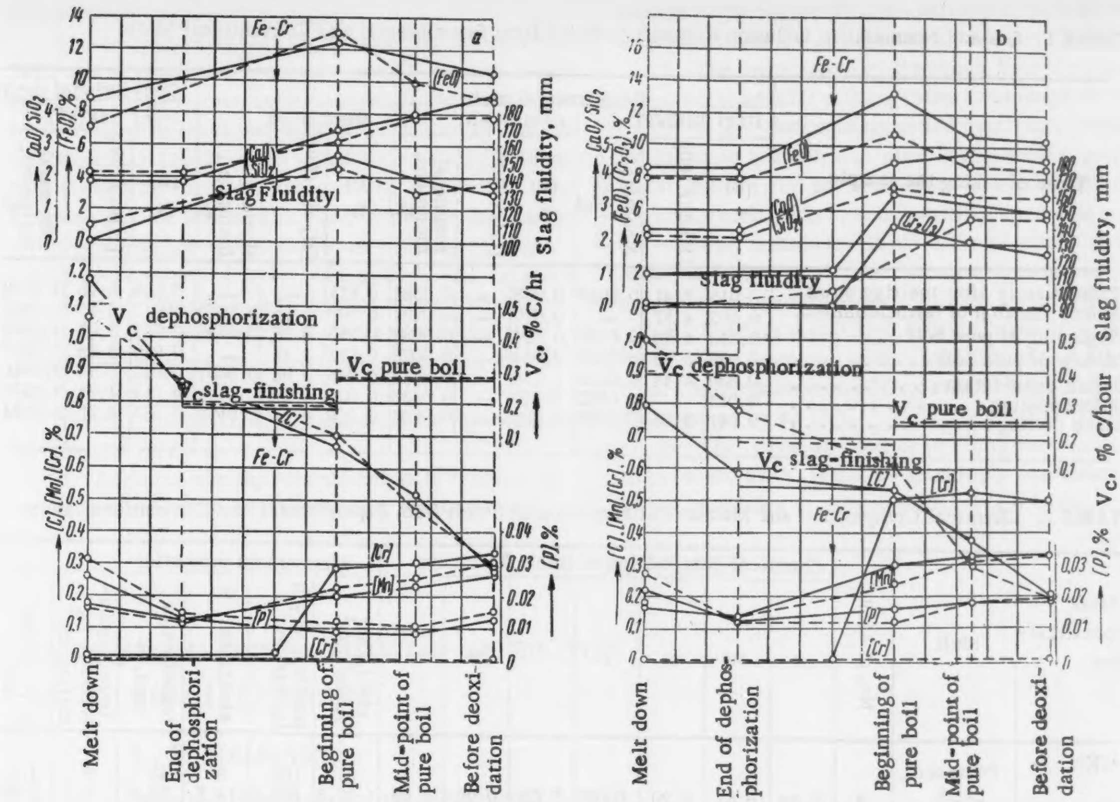
The lengthening of the slag-finishing period in melts with the ferrochromium added in refining is to be expected, since the quantity of materials added in finishing the slag is increased, and the carbon content in the bath is somewhat raised (by 0.05%); but normally the lengthening should not be greater than 15-20 minutes. This is borne out by the smelting of steel 40Kh, in which the slag-finishing was lengthened on the average by 15 minutes, and by the smelting of steel NL-2, in which the finishing of the slag in the experimental melt came out even three minutes shorter than in conventional melts.

A comparison of the average values of the rates of oxidation of carbon in experimental and conventional melts (see figure) in the different periods shows that in the dephosphorization period the rates are practically identical in the two-groups of melts.

In the slag-finishing period the rate of oxidation of carbon in experimental melts of steels 40Kh and 20Kh is naturally somewhat less than in conventional melts (by 0.02-0.03% carbon per hour) since the ferrochromium introduces about 0.05% carbon. In melts of steel 18KhGT and NL-2 the rate of oxidation of carbon was low, which appears to be a consequence of the irregular sequence in which the materials were added to the bath. Thus, whereas in melts of steel 40Kh and 20Kh iron ore was added in the slag-finishing period in two batches, namely, after the addition of the slag-forming mixture and after the addition of ferrochromium, in melts of steel 18KhGT and NL-2 a small amount of iron ore was added after the complete finishing of the slag and the addition of ferrochromium. Since the sample of the boil was taken five to ten minutes after this, it is natural that the rates of oxidation of carbon in the slag-finishing period in these melts were excessively low.

When the experimental melts are carried out normally, the rate of oxidation of carbon in the various periods of refining should be practically identical to the rates of oxidation of carbon in these periods in conventional melts.

A comparison in experimental and conventional melts of the change in the carbon, manganese, chromium and phosphorus contents in the metal and also of the basic characteristics and Cr_2O_3 content in the slag shows that in smelting steel 40Kh (see the figure) the experimental melts differ from the conventional melts only in the basicity and higher ferrous oxide content in the slag at the end of the pure boil and by the presence in the metal at this period of considerable concentrations of chromium.



The change in the average concentrations of elements in the metal and the change in the basic characteristics of the slag in experimental (full lines) and conventional (dashed lines) melts; a) steel 40Kh, b) steel 18KhGT.

In smelting steel 18KhGT the experimental melts differed from the conventional melts also in the higher basicity of the slag and the greater ferrous oxide content in the slag in the refining period, but chiefly in the presence in the metal at the beginning of the pure boil of about 0.5% chromium, and in the slag of about 5% Cr_2O_3. As can be seen from the figure, the presence of such a concentration of Cr_2O_3 in the slag does not exert any influence on the fluidity of the slag, which in experimental melts was even higher than in conventional melts, because of the good heating of the bath.

Thus, the chromium content in the metal in experimental melts of steels 40Kh and 20Kh varied from 0.27 to 0.33%, in melts of steel 18 KhGT and NL-2, from 0.49 to 0.62%, while the Cr_2O_3 content in the slag varied from 3.85 to 6.09%.

In the process of the pure boil, during the smelting of steels 40Kh and 20Kh, the chromium content in the metal rose somewhat and reached 0.33 to 0.40%. In smelting steels 18KhGT and NL-2 the chromium content at the moment of deoxidation decreased to 0.40-0.57%, which is explained chiefly by the increased degree of oxidation of the bath because of the decrease in the carbon content in the metal to 0.11- 0.13%. In the slag the Cr_2O_3 content before deoxidation decreased and varied in the range 3.06-3.98%.

Because of the high basicity of the slag (3.5-4.9) and because of the increased FeO content in the slag (10.8-12.6%), the assimilation of chromium introduced by the ferrochromium was considerably smaller (from 50 to 69.8%).

As can be seen from Table 1, the oxygen content in the metal during the course of the melts constantly rises, reaching before deoxidation a concentration of 0.043%; at pouring it is reduced to 0.014-0.30%; in the ladle it is increased to 0.041-0.53% (steel 18KhGT) or decreases to 0.008-0.026% (steels 20Kh and NL-2).

In the period of dephosphorization and finishing the slag, because of lime additions, the hydrogen content increases considerably and reaches in experimental melts 4.87-5.15 cc/100g, and in conventional melts 6.13 cc/100g. Toward the beginning of the pure boil in experimental melts the hydrogen content is either reduced somewhat (18KhGT) or remains at the same level (NL-2). Additions of ferrochromium do not themselves increase the hydrogen content in the steel.

In the second half of the pure boil the hydrogen content in the metal increases in the majority of cases, because of the considerable exposure during its intense boil.

In the process of deoxidation the hydrogen content of the metal, both in experimental and in conventional

TABLE 1. Gas and Nonmetallic Inclusion Contents in Steels from Experimental and Conventional Melts

Time of taking the sample	Experimental melts									Conventional melts		
	steel 18KhGT			steel 20Kh			steel NL-2			steel 18KhGT		
	[O] %	[H] cc/100g	Nonmetal inclusions, %	[O] %	[H] cc/100g	Nonmetal inclusions, %	[O] %	[H] cc/100g	Nonmetal inclusions, %	[O] %	[H] cc/100g	Nonmetal inclusions, %
Immediately after melting down	0.015	2.41	0.0037	0.008	—	0.0385	0.011	—	—	0.008	3.28	0.0096
Before addition of ferrochromium	0.002	4.87	—	0.010	—	0.0224	0.009	5.15	0.0050	0.017	6.13	0.0056
Beginning of pure boil	0.013	4.49	0.0120	0.024	—	0.0033	0.015	5.16	0.0136	0.012	5.07	0.0080
Middle of pure boil	0.020	3.86	0.0026	0.034	—	0.0026	0.017	3.42	—	0.019	3.58	0.0037
Before deoxidation	0.030	4.44	0.0013	0.038	—	0.0033	0.043	3.96	0.0051	0.027	3.45	0.0041
Before pouring	0.014	—	0.0262	0.020	—	0.0438	0.030	5.17	—	0.014	4.84	0.0370
Since casting	0.041	3.98	0.0228	0.008	—	0.0096	0.026	4.66	0.0129	0.053	4.71	0.0234

TABLE 2. Chemical Composition and Mechanical Properties of Steels from Experimental and Conventional Melts

Steel specification	Melt	No. of Melts	Chemical composition of steel, %							Mechanical properties					
			C	Mn	Si	P	S	Cr	Ni	yield point J_s, kg/mm²	tensile strength J_B, kg/mm²	elongation, %	reduction in area, %	Impact resistance α_k, kg meters/cm²	D_{cast}, mm
40Kh	Per specif.									80	100	9	45	6	4.1
	Exptl.	3	0.39	0.53	0.20	0.021	0.020	0.92	0.09	97.5	108.5	14.5	52.8	8.9	3.38
	Convent'l.	10	0.40	0.64	0.22	0.028	0.020	0.98	0.08	101.2	109.8	13.6	53.6	7.2	3.38
20Kh	Per specif.									60	80	10	40	6	4.5
	Exptl.	4	0.18	0.52	0.23	0.022	0.019	0.78	0.09	77.8	89.0	15.4	51.8	10.2	3.78
	Convent'l.	15	0.18	0.59	0.25	0.024	0.020	0.82	0.08	79.0	89.5	15.8	51.7	10.3	3.73
18KhGT	Per specif.									90	100	9	50	8	
	Exptl.	2	0.20	0.82	0.25	0.021	0.016	1.11	0.08	109.2	111.8	8.3	63.7	11.6	3.53
	Convent'l.	15	0.19	0.94	0.25	0.022	0.018	1.10	0.08	102.0	104.8	9.1	63.7	12.1	3.46

melts, is markedly increased, because of the transfer of hydrogen from the slag into the metal.

A comparison in experimental and conventional melts of the average values of the content of gases and nonmetallic inclusions indicates that upon the addition of ferrochromium in refining, the content of gases (O_2, H_2) and nonmetallic inclusions in the final metal is somewhat decreased in comparison with conventional melts, which must be explained by the beneficial influence of the boiling of the bath on the elimination of these gases and inclusions. Despite this, the nonmetallic-inclusion contents fo experimental and conventional melts are almost the same.

As can be seen from Table 2, experimental melts differ somewhat from conventional melts in their chemical composition: the manganese content is smaller (by 0.06-0.11%) in steels 40Kh, 20Kh and 18KhGT; the phosphorus content is larger (by 0.007%) in steel 40Kh; the chromium content is smaller (by 0.06-0.10%) in steels 40Kh and 20Kh.

This difference in the chemical composition of experimental and conventional melts does not allow a detailed comparison of the mechanical properties of the metal to be carried out; however, from Table 2 it follows that, in all the mechanical characteristics, after heat-treatment as stipulated by the different specifications—except the percentage elongation of steel 18KhGT—steels smelted with the addition of ferrochromium in refining have higher mechanical properties than are required by the technical specifications, and are practically identical to ordinary melts.

This bears witness to the fact that the quality of the steel is not impaired by this technique of carrying out the melt.

In calculating the economics of smelting steel with the addition of ferrochromium in refining, it is necessary to take into account the cost of the bauxite and lime added in refining (since the smelting technique is somewhat modified), the cost of ferrochromium added in refining and for alloying, and also the cost of the extension of the slag-finishing period. Thus, it is necessary to bear in mind the fact that the 1500-2100 kg of ferrochromium added to the melt in refining made it possible to reduce the consumption of ferrochromium in alloying steel 40Kh from 3050 kg to 1600-1800 kg in 20Kh from 2860 kg to 1300-1600 kg; 18KhGT from 3760 kg to 1800-2200 kg and in NL-2 from 1170 kg to 570 kg —that is, on the average by 42-52%.

In the experimental melts of steels 40Kh, 20Kh and 18KhGT a reduction in cost was observed; while in smelt-

ing steel NL-2 a very small increase in the cost of production occurred.

The analysis shows that, in the smelting of steels 40Kh, 20Kh and 18KhGT, the financial saving is obtained chiefly because a considerable part of the expensive ferrochromium used for alloying (Khr1 and Khr4) was replaced by cheaper ferrochromium (Khr6), which was added in refining. Although in doing this the total loss of chromium, and also the consumption of lime and bauxite, were increased, this expensive ferrochromium substitution gave a savings of from 1 ruble 30 kopecks to 3 rubles, 60 kopecks in cost per metric ton of steel. The increase in the cost of steel NL-2 on smelting it with ferrochromium added in refining is brought about by the increased loss of chromium—42.8%—in the refining period.

On the basis of the work carried out the following conclusions can be made.

1. Additions of scrap ferrochromium in refining do not give rise to difficulties in smelting chromium and chromium-nickel steels. Slags with an increased Cr_2O_3 content at the beginning of the pure boil in the high temperature conditions are obtained with adequate fluidity.

2. The assimilation of chromium from the scrap ferrochromium added in refining varies in the range 50-70%.

3. In gas content (oxygen and hydrogen), in nonmetallic-inclusion content, and, also, in mechanical properties, metal smelted with the addition of ferrochromium in refining does not differ from metal smelted according to the conventional technique. In all the mechanical characteristics the figures considerably exceed the requirements of the technical specifications.

4. The fact that 0.33-0.58% Cr is obtained in the metal at the beginning of deoxidation makes it possible to reduce the consumption of ferrochromium in alloying, on the average, by 42-52%.

5. The production cost of smelting one metric ton of steel (40Kh, 20Kh, 18KhGT) when scrap ferrochromium is added in refining is reduced from 1.3-3.6 rubles.

DESIGN AND OPERATION OF AN 80-TON ELECTRICAL FURNACE

L. S. Katsevich

Special Design Bureau of the "Élektropech'" Trust

The beginning of 1959—the first year of the Seven-Year Plan—was marked by an important event in Soviet electrometallurgy: on January 7, the first heat was tapped from the largest arc furnace in the USSR, the DSP-80 of 80 ton capacity, designed by the Special Design Bureau of the "Elektropech'" Trust and constructed by the Novosibirsk Plant for Electrothermal Equipment in cooperation with Soviet engineering and steel plants. March 31 saw the first heat from the 2nd 80-ton furnace.

The installation of two large arc furnaces is the first step in the realization of the recent resolution of the Communist Party. At the Twenty-first Conference of the Communist Party of the Soviet Union it was decided to increase the smelting of electrical steel in the USSR by 1.7-2 times. The experience obtained in designing, constructing, assembling and operating the first 80-ton furnaces will help Soviet industry to install and operate still more powerful arc furnaces.

The technical specifications of the 80 ton furnace are given below.

Internal diameter of furnace shell, mm	6300
Power of the transformer at the upper stage of the secondary voltage, kw	25000
Limits of secondary voltage of transformer (23 stages in 13v steps), v	417–131
Maximum (linear) current, amp	34500
Number of phases	3
Current frequency, cps	50
Electrode diameter, mm	550
Number of electrodes	3
Diameter of decomposition of electrodes, mm	1750
Maximum travel of electrode, mm	3000
Rate of movement of electrode with minimum speed of motor, m/min	1.7
Height of smelting space (from baffle plate to top of shell), mm	2300
Dimensions of working window, mm	1050×1250
Time of inclination of furnace at an angle 40°, minimum, min	1.5
Specific consumption of electrical energy in the smelting of a solid charge (approximately), kw-hr/ton	420
Maximum flow of cooling water m^3/hr	60
Pressure of oxygen in pneumatic cylinders of the mechanisms gripping the electrodes (minimum) atm	4
Total weight of metal construction of furnace (without mixing device), tons	430

The base of the furnace is a 2-sector cage resting on 2 welded foundation beams. The furnace is tilted by means of 2 racks connected by hinged joints with the rear ledges of the cage sectors. Each rack is driven by a separate drive. Since both of the drives for the tilting mechanism are not -self braking, they are fitted with brakes which automatically stop the drive after the electrical motor has been switched off. If necessary, the furnace can be tilted by one drive when the brake of the second drive is freed. Both of the tilting mechanism drives are placed to one side of the cage sectors, which prevents their being sprayed when the slag is run off; this also frees the lower part of the furnace between the sectors so that a trolley can pass under the furnace with the slag ladle.

On the furnace there is a mechanism for rotating the bath about a vertical axis; this mechanism has two drives, working together or separately (in the latter case it is essential to free the brake of the second drive).

The DSP-80 electrical furnace is the first Soviet furnace with a rotating roof. All previous Soviet arc furnaces had either a stationary roof (charging through a window) or a bath which could be rolled out (top charging).

During the planning, a simple mechanism was designed for rotating the roof with an integrally cast rotating pedestal, seated on a conical cantilever of a vertical shaft of 750 mm diameter. This shaft (resting on two radial self-aligning roller bearings and on a spherical self-aligning thrust bearing) is rotated by a geared quadrant from a drive similar to the drive for the bath rotation mechanism.

The roof of the furnace is hung at four points by chains to two cantilevers of a semiportal, fastened along the edges of the rotating pedestal. The roof is hoisted by two worm hoists mounted on the rotating pedestal. The worm gears of both hoists are connected by a shaft with two geared half clutches, so that if necessary the roof can be hoisted by one electrical motor with brief overloading. The mechanism for lifting the roof is designed for a maximum load of 50 tons.

The mechanisms for moving the electrodes are mounted on the rotating pedestal in the gap between the supports of the half portal. For the particular roof rotation mechanism, the simplest method was fixing the electrode holders on carriages. This was because telescopic tables (which have definite operating advantages over carriages) could not be accommodated within the limited dimensions of the cast rotating pedestal.

In the mechanism for moving the electrode, the cable was fastened to the drive drum (in contrast to the usual arrangement with friction fastening of the cable). The electrodes are lowered under the action of the weight of the unbalanced part of the carriage; during this stage, the mechanism for moving the electrode runs idle. This arrangement has two operational advantages: minimum compressive load on the electrode when it is resting in the charge and reduced wear on the cable which operates in the grooves of the drum without slipping. However, for reliable operation of the movement mechanism, an essential requirement is that there should be no failure in the limiters determining the extent of carriage lift and in the traveling cut-out which acts when the cable weakens.

The sleeve for the electrode holder is of seamless steel pipe of diameter 426 mm. Its front flange is connected with the cast bronze body of the electrode holder and the rear flange is fastened through an electrically insulated washer to the body of the carriage, made of nonmagnetic steel. The carriage has 16 guide rolls with antifriction bearings moving along machined strips of a stand mounted on the rotating pedestal. The current is fed to the electrode holder body by two copper pipes 150×10 mm insulated from the carriage body.

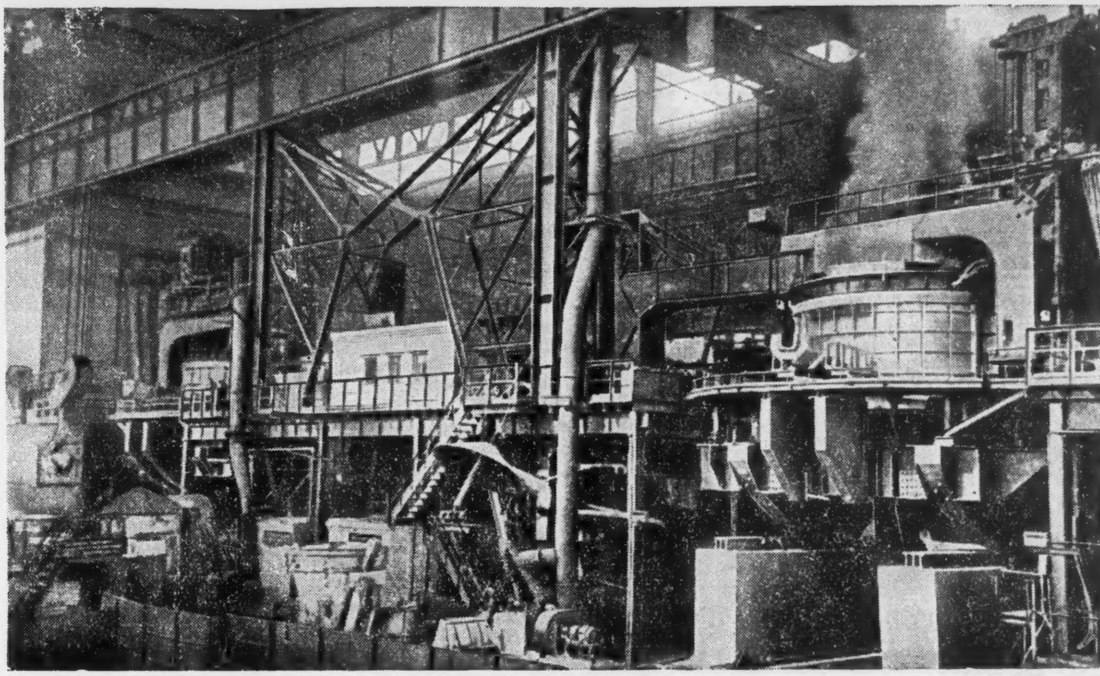
The usual system for secondary current supply in arc furnaces both in the Soviet Union and abroad is "star arrangement of electrodes." The DSP-80 furnace, however, was the first to develop a secondary current supply with "triangular arrangement of the electrodes." To avoid complicating the design of the secondary current supply and the associated operating difficulties, the triangular arrangement of the electrodes was made asymmetrical, i.e., with magnetic compensation of only 4 phases of the current supply instead of 6.

The flexible lead of the first two DSP-80 furnaces was made in the form of 6 chains of bare copper cables MGÉ-500 (32 cables in each chain). This arrangement was used because there were no cables of larger cross section.

The distinct technical advantage of a rotating roof furnace has been apparent since the first days of operation. In the case of a furnace where the bath is rolled out, the working platform in front of the furnace has a large cut out section which is covered by a moving platform. A furnace with rotating roof, however, has a stationary continuous working platform which has high structural strength. Furthermore, the space under the working platform of a furnace with rotating roof is free, whereas with the other type of furnace this space is occupied by the moving platform and the supports of the system for hauling the bath. The fact that there is no heavy and cumbersome mechanism for hauling the bath and also no moving platform with two mechanisms means that the mechanical part of a furnace with rotating roof is much more reliable.

Before the first furnace started operating it was feared that the mechanism for rotating the roof would introduce complications in the operation. These fears were not justified and the mechanism for rotating the roof has been completely reliable in operation.

With planned speed of rotation of the roof (3°/sec) there was considerable rocking of the portal with the roof after the rotation drive had stopped, which sometimes led to breaking of the electrodes. The speed of



In an electrical steel smelting shop with 80-ton arc furnaces.

rotation was therefore halved and an additional open cylindrical couple was added to the drive arrangement. This resulted in a considerable increase in the time of rotation of the roof but also a considerable reduction in the shaking.

The mechanisms for tilting the furnace with two nonself-braking drives and mechanism for hoisting the roof with two worm hoists connected by a high-speed shaft were found to be reliable in operation.

The mechanism for rotating the bath with two nonself-braking drives works very reliably, the power of one drive being quite sufficient to rotate the bath when the motor of the second drive is switched off. The design of the pedestals on which the annular beam of the lower part of the shell is supported was found to be very convenient in operation. The cast open cantilever with one support and one thrust roller prevents seizure of the rolls and the antifriction bearings in the rolls considerably reduced the power required to rotate the bath.

On the basis of operating experience with Soviet furnaces of 10-40 ton capacity and certain foreign furnaces, where the bath rotation mechanisms were not sufficiently reliable, many metallurgists considered bath rotation to be undesirable. Mechanics were of the opinion that the weak bath rotation mechanism was an additional source of breakdowns.

The desirability of rotating the bath of an 80-ton furnace has now been established conclusively. In the development of a 180-ton furnace to operate with the scrap process it is essential to give consideration to a bath rotation mechanism.

The initial stage of operation has shown certain design faults in the mechanism for moving the electrodes. These are mainly due to the unsuitable guide devices both for moving the carriage outside the stand and also for moving the balance weight inside the stand. Despite the fact that all guide rolls of the carriage had antifriction bearings, during operation the carriage sometimes stuck in the guides of the stand.

Furthermore, the axes of rotation of the guide rolls were not reliably located in the regulating cams, which meant that the rolls moved under the action of the large cantilever loads on the body of the carriage. The compound balance weight, consisting of a large number of unmachined iron weights, had an insufficiently rigid central rod of diameter 50 mm. When the balance weight was assembled, there was a large residual strain in the rod due to bending, which, resulted in the bent balance weight rubbing against the guides of the stand.

During operation, the jamming of the carriage and balance weights was eliminated. This was achieved by constructing the balance weights in the form of a rigid arrangement of slabs. To reduce friction when the furnace is operating in the tilted position, the balance weights should have guide rolls with antifriction bearings.

To prevent short circuits arising during operation the suspension of the flexible bare cable chains was changed near the transformer leads, the suspension was made the same as the current leads near the electrode holders. With this type of suspension the chains could be insulated with rectangular section wooden insulating clamps, adjacent chains being insulated by wooden spacers.

The geometrical dimensions of the furnace permit a simultaneous loading to the nominal capacity with a volumetric weight of the charge of 1500-1600 kg/m^3. In actual fact the charge entering the furnace has a volumetric weight of about 1100-1300 kg/m^3, which means that 60-65 tons can be loaded at once. Under these conditions the furnace must operate with one and sometimes two additional chargings, which considerably increases the smelting time and reduces the furnace productivity.

Since the additional charging is unavoidable with light scrap, it would seem desirable to increase the total furnace charge to 90-100 tons. However, the 125-ton casting crane selected by Gipromez can only receive 80 tons of molten metal into the ladle, which excludes the possibility of increasing the furnace productivity. For a furnace of nominal capacity 80 tons, the capacity of the casting crane should be not less than 150 tons.

AN APPARATUS FOR THE HYDRAULIC CLEANING AND LUBRICATION OF MOLDS

V. F. Zarubin

Magnitogorsk Gipromez

At a number of Soviet plants, after the ingots have been removed, the internal surfaces of molds are still cleaned manually, an arduous and unpleasant process. A number of methods have been suggested to mechanize the removal of scale and slag from molds using wire brushes, mechanical scrapers, etc. Owing to their poor design, not one of these methods has been given widespread application.

In 1945, at the Magnitogorsk Metallurgical Combine a machine was constructed and put into operation for lubricating molds. The machine resembles a cantilever crane and moves along the molds. The lubrication is provided by a spray which is loaded into the mold and sprays varnish onto the inside walls of the mold. With certain changes this machine is still being used in the Combine.

Since 1952, an apparatus has been operating at the Magnitogorsk Metallurgical Combine which cleans the molds with high pressure water and also has an arrangement for lubricating the molds*. Many years experience with this apparatus have shown that the cleaning of the internal mold surface with high pressure water is highly efficient and considerably improves the working conditions.

For the new open hearth shop at the Magnitogorsk Steel Combine a new combined apparatus is being planned for the hydraulic cleaning and lubrication of molds (Fig. 1). The apparatus has 6 sprays for cleaning and 6 for lubricating the molds (2 each for the molds on the trolleys in 2 rows, and 4 each for molds in a single row). The sprays on the upright posts are rigidly fastened in pairs to the cross beams, which are moved vertically up and down by means of electrical winches. The high pressure water for cleaning and the varnish for lubrication are fed to the sprays along steel pipes with hinged joints. To give a certain amount of balancing of the forces arising at the joints, the members are arranged crosswise.

While the sprays are lowered into the mold and raised upward, jets of high pressure water clean the inside surfaces of 2 or 4 molds simultaneously, placed on one trolley. The molds are lubricated with varnish in the same way.

The molds are brought to the installation on casting trolleys, 2 or 4 on each trolley depending on the size of the mold and the method of casting. In the installation itself the group of molds is moved by a rack pusher with 2 pushing carriages mounted on the ends of the geared rack of the pusher. In this way the group of molds can be moved 12 m at a speed of 9.4 m/min.

The distance between the ctions for cleaning and lubrication is 5800 mm, i.e., equal to the length of one trolley. This means that the cleaning of the molds on the third trolley coincides with lubrication on the first, the cleaning of the molds on the fourth trolley coincides with cleaning on the second, etc. This arrangement also improves the drying of the cleaned molds, which are on an intermediate trolley before being sent for lubrication.

When the molds are in a single row in the trolley, the sprays are arranged longitudinally to provide simultaneous cleaning. When there are two molds on the trolley, the two free sprays of the four are switched off. In case of failure in one or two of the cleaning sprays, the second pair of sprays can be used, but in this case the molds on one trolley will not be cleaned in one operation but in two

For more detailed information on this apparatus see "Metallurg", No. 8 (1956) [See English translation].

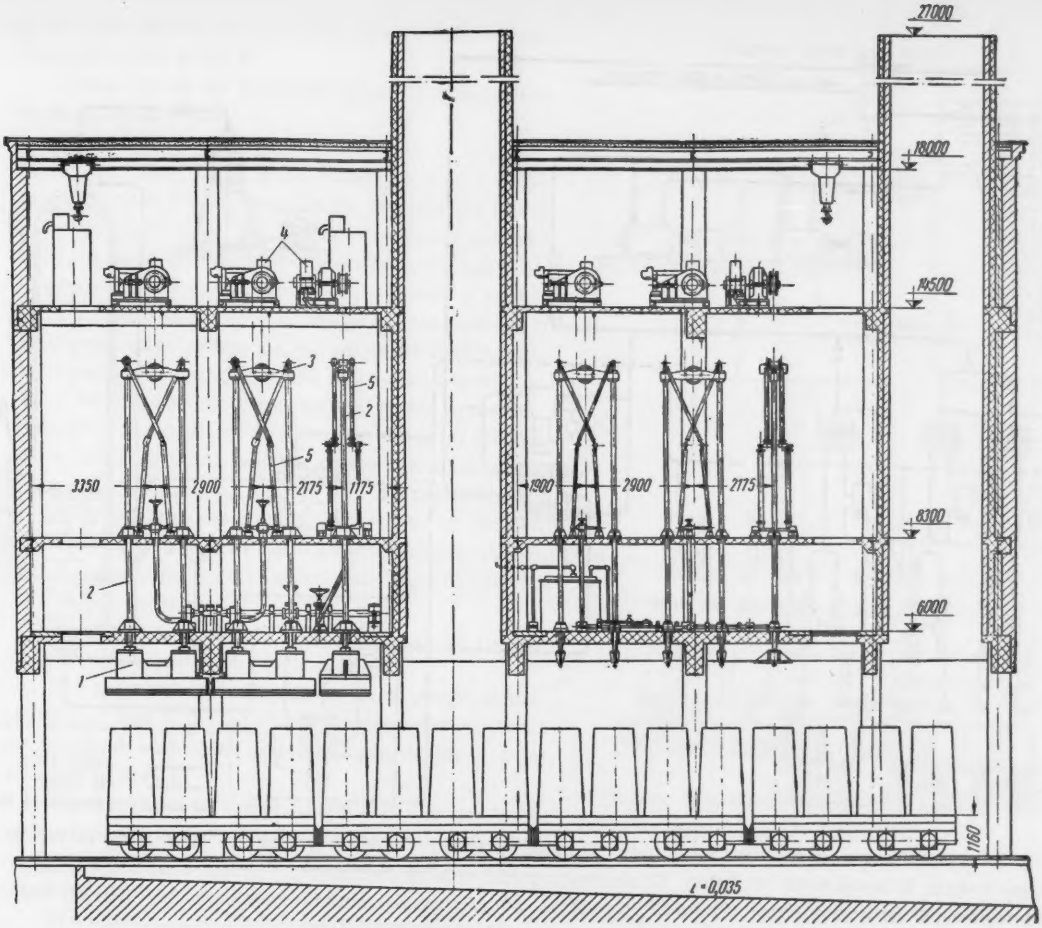


Fig. 1. Apparatus for hydraulic cleaning and lubrication of molds: 1) sprays for water; 2) bars; 3)cross arms; 4) electrical winches; 5) pipes with hinged joints.

with intermediate movement of the set. When the molds are arranged in two rows on the trolleys, the cleaning is done by two transverse sprays. The four molds standing on the trolley are then cleaned in pairs in two operations.

The distance between centers of the loads when they are in a single row on the trolleys is taken as 1450 mm or 2900 mm, and when they are in two rows only 2900 mm when there is 1700 mm between the axes of the rows (Fig. 2).

Increasing the distance between the mold centers to 1450 mm (instead of 1020 mm which is used at present in the Magnitogorsk Metallurgical Combine) considerably improves the temperature conditions of the molds during steel casting and increases their durability. Experience at the Combine has shown that reducing the distance between the mold centers from 1250 mm to 1020 mm resulted in a 15% increase in mold failure due to cracks.

The design of the sprays for hydraulic cleaning is similar to that for this type of apparatus in a plant in India. Each spray has 20 nozzles arranged alternately in two rows. For convenience in cleaning, the sprays can be taken apart. The nozzles are of 0.8x12 mm rectangular cross section.

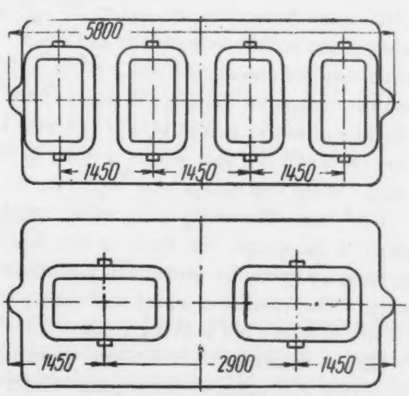


Fig. 2. Arrangement of molds on the trolleys.

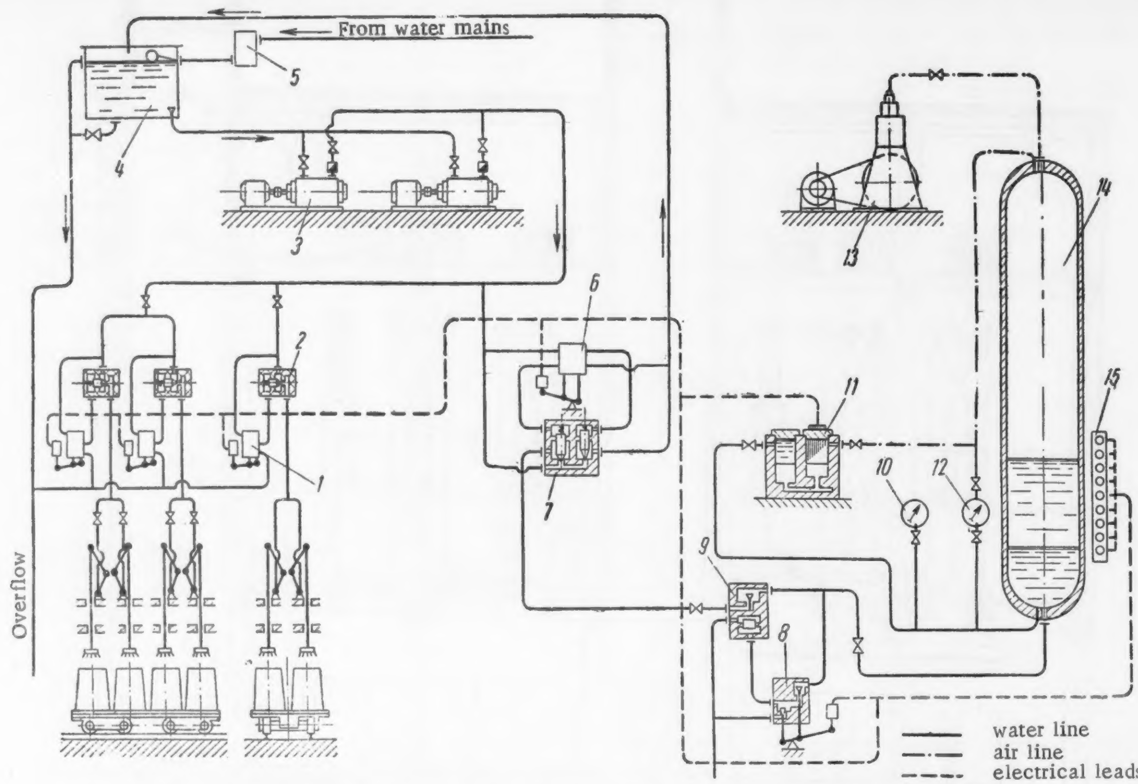


Fig. 3. Hydraulic system for cleaning molds: 1) electromagnetic 2-valve distributor; 2) floating valve; 3) pump 5P6×8; 4) water tank; 5) filter; 6) electromagnetic 4-valve distributor; 7) relief chamber; 8) electromagnetic 2-valve distributor; 9) automatic valve; 10) electrical contact manometer; 11) mercury box; 12) level indicator; 13) compressor; 14) accumulator; 15) signal light panel.

With water pressure in the system 50 kg/cm^2 and the exit area of the nozzle being taken as 12×0.8 = 10 mm^2, the water flow for one nozzle is 3.2 m^3/hr†. The plans include two pumps for feeding the water to the sprays (a working and a reserve pump) type 5P6×8 with 100 m^3/hr delivery (or 0.028 m^3/sec) with a pressure of 62 atm in the exit pipe. When four sprays work together, the water flow is 0.071 m^3/sec. The pump is therefore not able to supply the water to the sprays. To make up this deficiency in water, there is a hydraulic-pneumatic accumulator of 10 m^3 capacity. The volume of water in the accumulator is about 3 m^3, of which the working volume is not greater than 2 m^3. The accumulator is filled with water by the 5P6×8 pumps during the pauses when the groups of molds are moved by the pusher. Air leakage from the accumulator is compensated by a compressor with 26 m^3/hr delivery, the air pressure in the outlet pipe of the compressor being 60 atm.

The use of an accumulator in the hydraulic system compensates the maximum flow of water when cleaning the molds with 4 sprays simultaneously (permitting the use of a lower delivery pump) and reduces water hammer in the system. To measure and control the pressure and water level in the accumulator there are a level meter, electrical contact manometer, mercury switch, automatic valve, and relief chamber. The water level in the accumulator is measured by a level meter and a panel of lights. The impulse from the lights is fed to the mercury box with 9 contacts, which are closed in turn as the water level in the accumulator rises and open as the level decreases. An automatic valve closes to prevent water leaking from the accumulator below the permissible level.

The filling of the accumulator above the upper permissible limit is prevented by means of a relief chamber, the closing of the valves stopping the water supply to the accumulator, and the excess water is returned to the supply tank. The appropriate electromagnetic distributors feed the impulses for closing and opening the valves of the safety valve and the relief chamber from the mercury box. The sprays are switched on and off automatically when they are lowered or raised below or above a given level. The

†The flow of water is determined from the formula

$$Q = 14.01\ \mu\omega\sqrt{P}\ \text{m}^3/\text{sec},$$

where μ is the coefficient of water flow or the coefficient of the nozzle, taken to be $\mu = 0.9$; ω is the area of the exit hole of the nozzle, m^2; P is the water pressure in the system, kg/cm^2.

speed of descent and ascent of the sprays is 0.38 m/sec. The spray travel is 3.7 m.

Figure 3 shows the hydraulic system of the apparatus for cleaning the molds.

The molds are lubricated by sprays which spray on the varnish. The varnish is fed to the sprays by a Sh-35 gear pump with 2.1 m^3/hr delivery; the pressure in the outlet pipe is 25 atm. The sprays are switched on and off by means of cut-off valves mounted in the heads of the sprays. The varnish pressure in the system is controlled by a by-pass valve. When the sprays are switched off, the by-pass valve returns the varnish to the supply tank. Fig. 4 shows the arrangement for mold lubrication.

A locomotive brings the group of molds to the installation. The operator arranges the molds for cleaning, on the first trolley, and switches on the automatic system. Subsequent switching on and off of all mechanisms is automatic until the cleaning is finished and all the molds are lubricated. The plan also allows for manual switching of the mechanisms from a control desk when the automatic system is switched off.

Two 27 m air vents are provided to remove steam and varnish vapor from the equipment.

The spent water is removed by three troughs into a settler and then to the sewer. The scale which settles in the troughs is washed out periodically by means of a special siphon device.

This apparatus for the hydraulic cleaning and lubrication of molds, designed by the Magnitogorsk Gipromez, mechanizes and automates the laborious operations of preparing molds for steel casting.

The cleaning and lubrication of the molds on the one trolley can be carried out in 80 seconds, including the movement of the molds by the pusher. The apparatus can handle molds for steel castings at an open hearth shop with an annual production of 4.5-5 million tons. One operator controls the installation. Its planned cost is 1.66 million rubles.

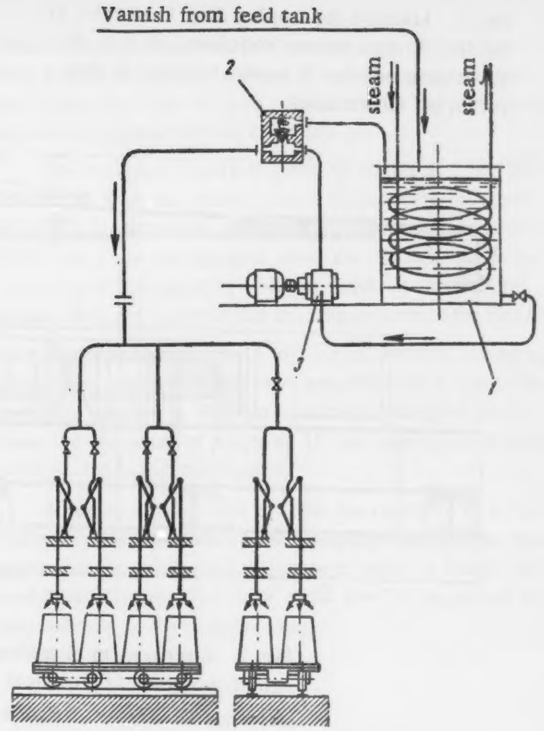


Fig. 4. Apparatus for lubricating molds: 1) varnish tank; 2) by-pass valve; 3) gear pump.

NEW EQUIPMENT FOR OPEN HEARTH SHOPS

I. I. Vinioli

A machine for tapping slag from a mixer. The Novokramatorsk Engineering Plant has constructed a new machine for tapping slag from a mixer (Fig. 1) and this machine has been installed at the Voroshilov Plant. The working part of the machine is a removable scraper fixed in a nozzle which is fastened to a cross beam with a telescopic extension. The cross beam can move in a vertical plane along a screw at a rate of 0.975 m/min. The height of ascent is fixed by a limiter.

The scraper and the hoist mechanism are mounted on a trolley which is driven by a pull chain in the form of two hinged plate strands. The driven sprocket of the chain can be moved by regulating the tension. The chain has 6 supporting sprockets to prevent it from sagging. The plates of the chain are made of steel 45 or 50, the spindles of steel 15KhA or 12KhN3A, bushes and rollers are steel 15.

The speed of the trolley is 35.24 m/min. Its traverse is limited by a final switch. The total weight is 5041 kg, the productivity of the machine is 120 kg/min. The machine is mounted on a frame opposite the overflow outlet of the mixer.

This machine for tapping slag considerably improves the working conditions at the mixer, provides good tapping of the slag, which in turn increases the durability of the lining and extends the campaign of the mixer.

Fig. 1. Machine for tapping slag: 1) scraper; 2) holder; 3) cross beam; 4) screws; 5) nut; 6) guide cross beams; 7) ascent limiter; 8) final switch off for traverse.

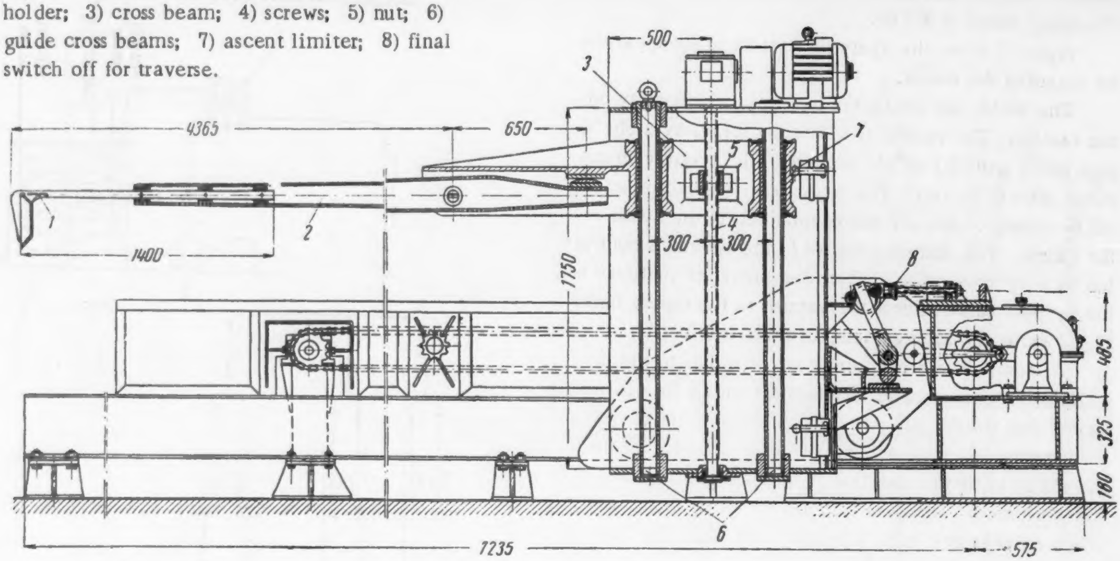
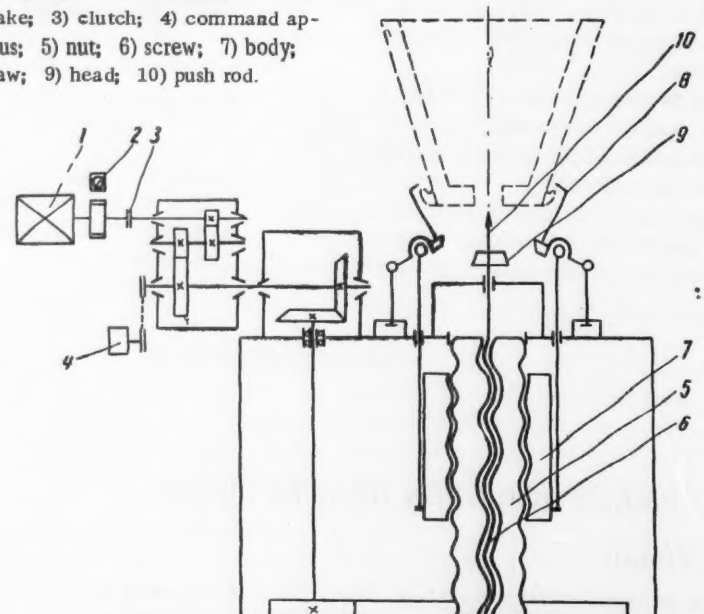


Fig. 2. Arrangement of machine for stripping ingots: 1) electrical motor; 2) brake; 3) clutch; 4) command apparatus; 5) nut; 6) screw; 7) body; 8) claw; 9) head; 10) push rod.



A mechanism for stripping ingots. In 1957 the Dnepropetovsk Plant for Metallurgical Equipment manufactured a stationary mechanism for removing ingots which had stuck in the molds. The force developed by the mechanism is 400 tons.

The machine (Fig. 2) was installed at the Voroshilov Plant; it is driven by an 80-kw electric motor through a friction clutch, designed for a limiting torque of 250 kgm. On the slow shaft of the reductor through a chain transmission the command apparatus is activated, with which the electrical motor of the machine is stopped at the final positions of the screw.

The drive rotates a nut which is connected by a spline with the hub of the last gear of the gear transmission; the

nut has an external and internal stop thread– the internal thread is a double start thread with a 96 mm pitch and the external thread is single start with 40 mm pitch; both threads are right hand. The nut carries a screw and the nut itself is screwed into the body. In one rotation from right to left the nut passes 96 mm along the screw, and since the external thread of the nut and the thread in the body have a 40 mm pitch, the body then descends 56 mm. On the body there are 4 bolts which hold 2 claws. Under the action of the balance weights and the control rods these claws close as the body descends and grip the mold by the "lugs"; the body stops descending and the screw begins to rise at a rate of 56 mm for one rotation of the nut. The head rises meanwhile together with the push rod. The push rod passes through the hole in the bottom of the mold, contacts the ingot and pushes it out.

After the screw with the head has ascended 300 mm, the command apparatus switches off the electrical motor and the ejection cycle for the ingot is finished. The electrical motor is then switched over to the return stroke. The head descends 300 mm to the stop on the lid, prevents the screw from further downward movement and with further rotation of the nut, the body moves further and causes the claw to open. At this point the command apparatus switches off the electrical motor.

The machine is able to push out ingots of 970-1220 mm width from the molds. Good results were obtained when the machine was tested under production conditions. Difficulties are encountered when the friction clutch incorrectly or inaccurately controls the final instant (the pusher does not transmit the maximum force to the screw).

The machine ejects 15-ton ingots without damaging the molds, which is not always possible with a crane. The machine can free a 250-ton 3-operation stripper crane from the operation of stripping 15-ton ingots, which saves wear on the crane mechanism.

It would be desirable to have the machine in a separate bay equipped with a 30-ton bridge crane, thus eliminating the necessity for the stripper crane to install the molds with ingots; the work could then be organized independently of the stripper crane.

EXPERIENCE ON THE PRODUCTION OF TIN PLATE

K. S. Evsevskii

Deputy Head of the Tin Plate Shop at the Magnitogorsk Metallurgical Combine

The tin plate shop for the hot-dip process was put into operation in 1957. The products of the shop include car plate, passivated steel and dynamo steel plate of 0.3-0.6 mm thickness as well as tin plate. The design of the shop provided for a modern continuous pickling machine, powerful rolling and dressing mills, units for electrochemical cleaning, furnaces for continuous annealing, machines for transfer, cutting and continuous sorting, automatic units for hot-dipped tin plate and electrolytic tin plate.

The technological process for the production of the steel base for tin plate at the MMC consists of the following.

Steel from large-capacity open-hearth furnaces is top poured into the molds. The chemical composition of the steel is: not more than 0.09% C, traces of Si, 0.3-0.45% Mn, not more than 0.03% P, not more than 0.03% S. 7 and 9-ton ingots are delivered at a temperature of 500-800° C to the soaking pits of the blooming mill. After they are heated up to 1250° C in 2-3 hrs, the ingots are rolled on the cogging mill into a section 105×765 mm.

Two slabs each 4200-4800 mm long are transported by rail bogies to the dressing section of the continuous thin-sheet mill where, after cooling and thorough inspection and the removal of surface defects by flame scarfing and pneumatic chippers, the sections are charged into continuous reheating furnaces. After being heated for 1.5-2 hours, the slabs are discharged onto the roller tables and rolled into strips 2.0 mm thick and 765 mm wide on the continuous thin-sheet mill. The coils of 2.5 ton weight are taken from the coilers at the end of the mill by an underground conveyer and are transferred into the hot-rolled coil storage of the pickling section at the hot-rolling shop.

The coils, cooled to 60° C, are transferred by a hoist to a decoiler and a scale breaker. The ends of the strip are cut off at a right angle by drop shears and are transferred on rollers to the electric butt-welding machine where they are welded into a continuous strip which subsequently passes through four pickling tanks containing H_2SO_4 solution (up to 20%) heated to 95° C; the velocity of the strip is up to 64 m/min.

To maintain a constant concentration of the acid solutions in the containers one uses the cascade method, i.e., the solutions first enter the fourth container and then overflow in turn into the preceding container and flow out of the first.

The sulfate is separated from the used-up solution in vacuum crystallization units and then the solution is returned to the pickling tanks.

After the strip is pickled the slime is washed off the surface of the strip in cold and hot washing tanks. The strip, which weighs 10 tons, is then dried with hot air and cut with rotary shears to the required width, oiled with palm oil in a special shower unit, wound into a coil and transferred on inclined roller tables to the 5-stand mill.

The technology of the electric butt-welding of strips has been mastered and about 80% of the total number of welded sections, subjected to a reduction of up to 90% on the 5-stand mill, pass through the mill undamaged.

The coiling machine, designed for a tight and even coiling of the pickled strip, was found to be unsatisfactory. It was necessary to replace it by an ordinary roller-type coiler which ensured that the coil was lined up at the edge but was not tightly wound so that there was no opportunity of using the separating machine of the decoiler before the 5-stand mill and, therefore, the coil turns tended to shift during the rolling, thus, causing scratches and slivers on the strip.

To prevent damage to the strip it was necessary to dispense with the back tightening by the decoiler, and now the strip is made taut by wooden press guides before the rolls of the first stand.

The five-stand four-high mill is equipped with electromagnetic transfer for the strip from the decoiler to the 1st stand, an isotope and flying micrometers for measuring and controlling the strip thickness after the first and fifth stands, tensometric rollers for establishing and controlling the tension in the strip between the stands and a leather catcher for the strip at the coiler, spray jets for the delivery of palm oil onto both sides of the strip in front of the second, third, fourth and fifth stands, liquid-friction bearings and a cooling system for the back-up and working rolls.

The back-up rolls of the mill have a 1300 mm diameter, they are 1200 mm long, and are mounted on liquid-friction bearings; the working rolls are made of 9Kh2 steel, have a 500 mm diam., are 1200 mm long, and are mounted on roller bearings. At present, liquid-friction bearings for working rolls are being tested. The service life of the working rolls in 1958 constituted 5000 tons of rolled steel when bulk hardening was employed and 3,500,000 tons when surface hardening with

the use of industrial-frequency current was employed.

When black plate is rolled, the rolls are cooled with emulsion, and when tin-plate is rolled clean water heated to 25° C is used for cooling. Warmed-up palm oil, diluted with water, is sprayed onto the strip by means of jet sprayers which are installed in front of each stand (except the first). At present, tests are being carried out with a view to replacing the scarce palm oil by castor oil.

An automatic block system of the screw-down mechanism of the first stand and the flying micrometer behind the first stand, for checking long hot-rolled strip of nonuniform thickness at the edges, is being developed.

The strip is rolled in one pass from 2.0 mm to 0.25-0.32 mm thickness and is coiled on the coiler drum at a speed of 25 m/sec. On the basis of practical experience (accumulated in one year's operation) the most suitable rolling regime (with convex upper rolls) has been established: 0.18 mm for 400 mm diameter and 0.10 mm for 500 mm diameter. The drafts employed during the rolling of tin-plate are shown in the Table. When thicker tin-plate (0.28-0.36 mm) is rolled the same ratios of drafts and tensions between the stands are employed.

Drafts Used during the Rolling of Black Plate
2.0 × 7.35 mm – 0.35 × 7.35 mm

Stand	Entry speed mm	Working speed of 8-10 m/sec		Tension in strip (tons)	Convexity of the upper rolls, mm
		mm	%		
I	1.6—1.65	1.55	20.0	12—14	0.10
II	1.0—1.05	0.95	38.7	8—10	0.10
III	0.65—0.70	0.58	38.9	5—6	0.10
IV	0.45—0.50	0.37	36.3	2—3	0.10
V	0.35	0.25	32.4	1—2	0.12

For the removal of oil and dirt, after the cold rolling, all the coils are transferred to the electrolytic degreasing machine which is equipped with a decoiler, an electrowelding (spot) machine for butt welding the separate coils into a continuous strip, three washing machines (for strip washing), two electrolytic baths, cooling and stretching rollers, drying equipment and a coiling machine. The strip passes continuously at a speed of 5 m/sec through all the units and the tanks with the electrolyte solution, which is heated to 90° C and consists of 10 g/liter NaOH, 25 g/liter Na_2CO_3 and 25 g/liter Na_3PO_4.

The emulsifying agent for the degreasing bath is OP-7 or OP-10 (3 g/liter), and for the washing machines–H_2CO_3 (6 g/liter). The anode voltage in the bath is 6-8 v, and the current 12,000-15,000 amp. For the removal of dirt, the electrolyte and the alkaline solution from the washing machines are continuously recirculated and passed through a filter press.

Accurately coiled washed strips are transferred to rectangular gas furnaces. All the furnaces have three stands with three piles each and cylindrical muffles made of stainless steel. The coils are carefully transferred by a hoist (to avoid damage to the edges) and laid one on top of the other in a vertical pile of 90 and 120 ton weight with intermediate convection inserts, then they are covered with muffles, tightened at the bottom with sand seals and annealed to 640° C in the course of 25-34 hr and then kept for 6-8 hr. The cover of the furnace is then removed and transferred for the annealing operation on the next stand, and in 30-40 hr the coils under the muffle are cooled to 150° C after which they are transferred to be dressed.

The established annealing regime in an inert atmosphere of a gas produced in a special unit from a burning mixture of coke and blast-furnace gases ensures a clean surface and the required mechanical properties of the cold rolled metal which after the dressing is suitable for nonferrous coating.

After the installation of the circulation fans (provided for in the design) on the stands under each pile of coils, the cooling time of the steel was reduced substantially and the output of the furnace increased by a factor of 2.5.

The dressing of the strip is carried out on a two-stand mill with polished working rolls at a speed of up to 25 m/sec and a draft of 0.15-1.5%.

The two-stand mill has a loop-stretching roller attachment in front and behind the stands to facilitate the entry and provide tension in the strip, tensometric rollers between the stands for controlling the tension during the dressing, and an apparatus (now being installed) for determining the draft of the strip at the time of rolling between two stands, and between each stand and the loop-stretching rollers. In addition, the mill has an isotope micrometer for checking the thickness of the strip produced. The established dressing regime makes it possible to obtain a smooth strip with a clean glossy surface of the required dimensions and mechanical properties necessary for hot tinning.

The dressed strip is wound into coils on the coiler drum at the end of the mill and is transferred to the cutting machines where it is cut into sheets of the standard size (512 × 712 mm).

The coil is uncoiled, cut to the required width, straightened on the straightening machine and cut at a speed of 5 m/sec by flying shears into uniform-length sheets which are transferred by belt conveyors to a packing receiver, then laid into piles and taken by cranes for sorting.

It is planned to control the thickness of the strip of the sheets with an isotope micrometer and to detect any holes in the strip with a defectoscope which will automatically open the drop lid of the first receiver so that all defective sheets will be collected there; the sheets suitable for tinning will be collected in the next two receivers and will then be subjected to pickling and transferred to tinning without additional sorting.

At present, a modernized belt conveyer and pilers are being installed to provide for continuous inspection and sorting during the cutting so that the sheets will be transferred without manual sorting to the tinning machines.

Prior to the hot tinning, the sheets are subjected to white pickling in batch pickling tanks with hydrochloric acid solution (50-60 g/liter) heated to 35° C.

At the automatic tinning machine the sheet packets are transferred by hand to vessels with water and then each sheet in turn is taken by a magnetic feeder to the rollers of the fluxing machine, the distance between each consecutive sheet being 100 mm. Each sheet passes through a layer of melted flux in a compartment of the tank with molten tin at 320° C. During this operation, the remaining traces of moisture are removed from the sheets and the surface is prepared for an appropriate coating with a thin tin layer.

By means of guides and transfer rollers the tinned sheet is taken from the tinning bath, passed through three pairs of horizontal rollers of the oil bath where the excess tin is removed and the remaining tin solidifies uniformly and spreads in a thin layer on the surface. The tinned sheets then pass through the rollers of the washing machine, the drier, and undergo dry cleaning by means of nine pairs of horizontal flannel rollers where dry screened middlings are fed continuously by a distributing screw feeder. Finished sheets of tin plate from the tinning machine are stacked in piles in special receivers and are then transferred to inspection tables for sorting.

Sheets are collected in packets of 112 sheets each, they are then wrapped in waterproof paper, interlayed with cardboard, packed in special wooden crates, marked and transferred to storage. Tin plate is transported in closed cars.

With the object of a more extensive automation of the process, the design of the plant envisages the installation of a tank in front of the automatic tinning machines for the electrolytic pickling of sheets before the tinning, and the installation of mechanized sorting machines after the automatic tinning machines.

In addition to the above basic equipment the tin plate plant comprises: flux preparation, recuperation section for the removal of the tin layer from the scrap and waste; package workshop; a big covered storehouse for storing packing material; a workshop with machines for grinding and polishing the rolls, a mechanical workshop and an electric workshop.

The tin plate shop is equipped with up-to-date equipment which was for the first time designed and manufactured in the USSR.

THE USE OF A REPEATER FOR ROLLING ANGLES

N. I. Tereshenkov

Roll designer at the Uzbek Metallurgical Works

The finishing train of mill 300 consists of 5 reversing two-high stands arranged in one line. The stands are driven by a 1280 kw synchronous electric motor of 300 rpm. Round, square and rectangular sections are transferred from the first stand of the finishing train to the second stand by repeaters.

For a complete elimination of manual labor at these stands it was necessary to develop and introduce a repeater for angles which are also rolled at this mill.

When No. 4 angle is rolled the repeaters feed the section up from below (Fig. 1). The shape of the initial rough billet is shown in Fig. 2.

The turning guides are of cast steel; they turn the rolled piece clockwise (looking in the direction of the movement of the section) through 20°. The guides with the support are mounted on the block and their ends are pressed against the rolls by means of a lever and a counter-weight. The guides are fixed in their position on the block by bars mounted on both sides.

The trough of the repeater is made of cast steel; at its front and rear ends it has special lugs with holes for fastening it to supports mounted on the foundation. Up to the line A-A, the external wall is in an inclined position, and at the position B-B, the repeater is supported on the foundation bed through a rotating screw and a fixed nut attached to the repeater. The internal wall of the repeater is made of 500 mm plate welded to the repeater's trough.

The receiving guide (Fig. 3) turns the piece counterclockwise through 55°. The receiving guide is attached to the trough by means of a stirrup and its front end enters the entry guide. The entry guides are mounted in a

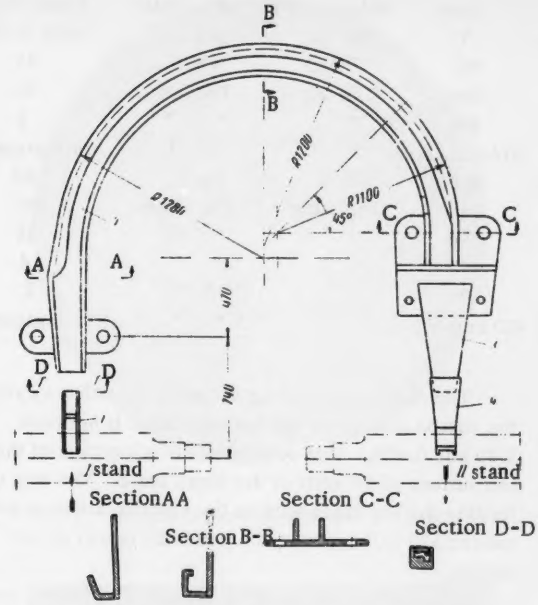


Fig. 1. Repeater for the transfer of No. 4 angle from Stand I to Stand II: 1) turning guide; 2) arc; 3) receiving guide; 4) entry guide.

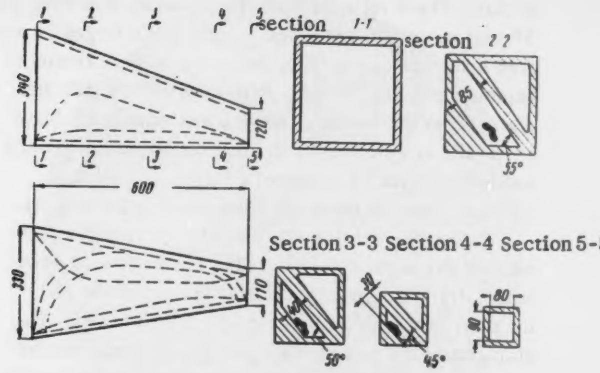


Fig. 3. Receiving guide.

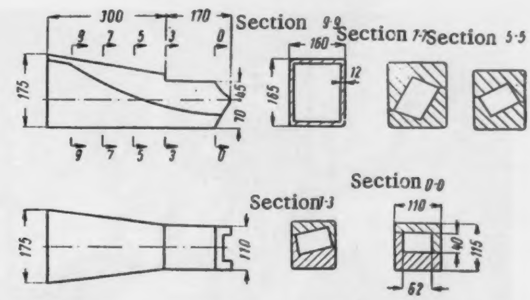


Fig. 4. Entry guides of the IInd and finishing train.

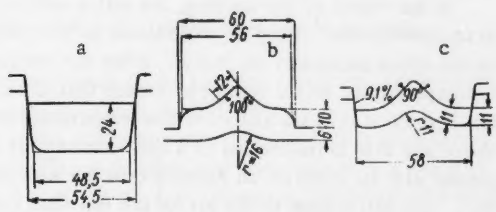


Fig. 2. Shape of section: a) after leaving the roughing stand; b) and c) after leaving the first and the second finishing stand respectively.

conventional-type box on the block and provide for a further turning of the piece through 30° to the horizontal plane. The entry guides are cast in two parts which are then welded together. Their internal surface is ground with an abrasive. The varying internal cross section of the entry guide (Fig. 4) ensures that the rolled piece turns gradually as it moves toward the rolls.

The introduction of the repeater made it possible to reduce the number of workers, to increase the output of the mill and to improve the quality of the angle by rolling it at a higher temperature.

The repeater described above has been in operation since 1956. At present, another apparatus of similar design for transferring No. 4 angle from Stand III to Stand IV is being tested.

BUILT-UP STEEL ROLLS OF THE THICK-PLATE MILL AND THE CAUSES OF BREAKDOWN OF THE ROLLS

M. A. Zadorozhnaya, P. Ya. Ryzhkov and L. A. Vorkova

Petrovskii Factory

The upper and middle rolls of the thick-plate three-high Lauth mill at the Petrovskii Factory are made of cast iron, and the lower roll is made of steel. For the improvement of their resistance to wear and the reduction in the roll consumption resulting from the wear of the working surface, the lower steel rolls are given a top

layer which is welded on automatically under a layer of flux. These rolls, 910 mm in diameter, 3 m long and 16 tons in weight, are made of steel 55Kh forged in normalized condition and are supplied by the Novo Kramatorka Machine Building Factory. Rolls worn down to 885 mm diameter in the course of service are written off. Less worn rolls as well as rolls in good condition are given a welded-on layer by means of a larger roll-welding machine made at the plant from a roll lathe (Fig. 1).

Before the welding-on, the rolls are machined to remove any surface defects. Ring cracks are removed especially thoroughly by circular turning of the roll, the sides of the groove cut being inclined at 30°. The diameter of the roll in machined places should not be less than 875 mm (in 1 m long middle part of the barrel), and not less than 870 mm at the ends.

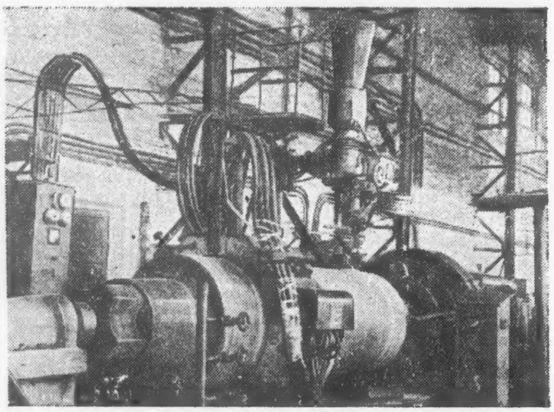


Fig. 1. Large roll lathe.

Prior to welding, concealed cracks are detected by a UZD-7N ultrasonic defectoscope. Rolls with internal and surface defects are rejected.

The rolls are built up by welded-on layers from electrode wire ÉI701 of 4 mm diameter, made to conform to GOST 5527-56, or wire PP-3Kh2V8 of 3.6 mm diameter, made to conform to ChMTU 5141-55. Flux AN-20 is employed. For the prevention of cracks in the built-up layer, the roll is heated to 370-400°C on the barrel surface and 150°C on the necks, before and during the welding process. The rolls are heated by means of an inductor.

The temperature is checked by a contact thermocouple and temperature-indicating pencil made of nickel carbonate (40%) and paraffin wax (60%). The pencils are made by the Factory Chemical Laboratory. The temperature is estimated by the change in color of a mark made with this pencil. The table below shows how the color of the line changes depending on the temperature of the roll.

The temperature is measured in five points along the roll simultaneously. If the process of welding has to be interrupted the whole surface of the roll is covered with a special asbestos jacket to prevent heat loss.

Surface temp. °C	Line color: Before heating up	After heating up	Time taken for color to change
250	Green	White	40
280	The same	The same	15
300	" "	" "	5
310 and above	" "	" "	Instantaneously
320	White	Black	60
340	The same	The same	30
360	" "	" "	15
380	" "	" "	4
400	" "	" "	2
410 and above	" "	" "	Instantaneously

The regime of welding is chosen in such a way that the carbon content in the built-up layer is between 0.46 and 0.49%. This corresponds to a hardness of the roll surface of 70 units of the Shore scale. The rate of feeding the electrode wire to the electric arc does not exceed 123 m/hr so that hot (circular) cracks do not appear.

The width of the built-up layer is 15-20 mm, the pitch is 8-12 mm, the fillets overlap by 7-10 mm, and the minimum thickness of the built-up layer is 2.5 mm. Under these conditions the speed of welding is about 40-50 m/hr; the maximum current of the arc should not exceed 550 amp.

In the course of the welding, the roll is subjected to an intermittent heating by an inductor to 370-400°C on the whole surface of the barrel. After the welding is completed the roll is tempered for the first time. For this purpose it is again heated to the temperature shown above and then is transferred to a slow-cooling pit and placed with its wobblers on supports covered with asbestos . The roll is kept in the pit for not less than three 24-hr days, it is then removed (at a maximum temperature of 100° C) and placed on wooden beams or stacked in a pyramid to cool down to a temperature below 40°C. After the dressing (rough machining and final polishing) the roll is tempered for the second time.

This method of building-up the rolls has made it possible to extend the service period for one change of rolls to 18 shifts (compared with 12.6 shifts for untreated rolls) and to increase the quantity of alloy steel rolled by a factor of 2-2.5 (50-65% by weight of the total steel rolled compared with 20-25% when untreated rolls were used).

The built-up rolls break down mainly because of fractures resulting from cracks in the built-up layer. The fracture has the characteristic appearance of a fatigue failure (Fig. 2). The cracks which form in the built-up layer cause stress concentration. The cracks are 30-200 mm deep; often a crack which starts on the surface of or in the built-up layer continues deep inside the base metal of the roll. On a specimen (Fig. 3) taken from a built-up roll and treated with 10% nitric acid (for the investigation of the macrostructure) one

Fig. 2. Fatigue failure of a broken built-up roll.

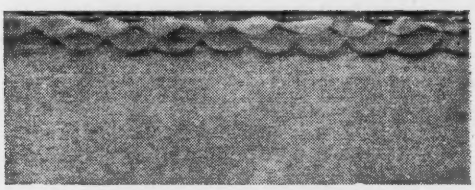


Fig. 3. Cracks in the built-up layer.

can see cracks in the built-up layer, one of the cracks passing deep into the roll body.

The microstructure of the built-up layer, as revealed by etching a polished specimen with 40% solution of nitric acid in alcohol, consists of highly alloyed ferrite and pearlite (Fig. 4) while the chemical composition of the layer is:

C	W	Cr	V	Mn	Si	S
0,49	9,04	2,40	0,31	1,20	0,60	0,023

Fig. 4. Microstructure of the layer built-up from 3Kh2V8 welding wire.

With the object of reducing crack formation, the new technological instructions (1959) envisage a reduction of carbon in the layer to 0.46-0.49% (compared with 0.49-0.53% according to the old instructions). Also, there is no doubt that the nonuniform prolonged preliminary heating and the long time taken for the welding process (seven days) result in a stressed condition of the roll and of the built-up layer and thus assist in crack formation.

The building-up of a top layer from ÉI701 and PP-3Kh2V8 electrode rods on the thick-plate mill rolls with the use of AN-20 flux is an advanced method of increasing their service life. To improve the quality of the built-up layer and to accelerate the processes of heating and welding, it is necessary to install a second inductor at the roll-welding machine (lathe) and to replace the one-electrode welding attachment by a three-electrode one.

ALL-UNION CONFERENCE ON PLATE ROLLING

The All-Union Conference on Plate Rolling was held in Zaporozh'e from June 9 to June 13, 1959. The Conference was attended by the staffs of metallurgical and machine-building plants, State Planning Commissions of the USSR and individual Soviet Republics, National Economic Councils, scientific research and design institutes, universities and technical schools, representatives of scientific and technical journals and newspapers, and of the Scientific and Technical Society of Ferrous Metallurgy, the Party, the trade union and Soviet administration workers.

The object of the Conference was to discuss and disseminate the experience of leading steel rolling plants as well as of design, scientific and research organizations, and to consider the problems of steel plate production in the 1959-1965 period.

More than 40 papers dealing with basic problems of rolled plate production, such as the production of thick and thin steel plate, and tin plate, the design and operation of reheating and heat-treating furnaces, methods of improving the quality and increasing the service life of rolls and the automation and mechanization of

plate production, were read and discussed at the Conference.

A. V. Istomin, the Head of the Steel Rolling Section of Gipromez, presented a paper on the present state and the development prospects of rolled plate production in the USSR. In 1958, our country produced over 11 million tons of steel plate and this is four times the output of 1940. The variety of rolled plate was substantially expanded; cold-rolled steel strip for tin plate as well as cold-rolled transformer and stainless steel came into production. The proportion of plate obtained from continuous and semicontinuous thin-plate mills, which are the most mechanized of the mills, increased considerably. During the current seven-year period six new shops with six plate mills are to be built; also two mills, 2800 and 4000-4500 mm, for thick plate production; one semicontinuous mill 2800/1700 mm and four continuous plate mills for the production of thin and some thick plate from carbon steel. It is envisaged to install a planetary mill as an experimental commercial plant for hot-rolled strip up to 1000 mm wide. In addition to the tin plate plant which has been put into operation, it is planned to build two more modern tin plate plants at the Magnitogorsk Metallurgical Combine.

The paper by V. M. Piskareva (Gipromez) on the plate rolling industry in USA was received with great interest. In recent years, the steel rolling industry in the USA has shown a rapid increase in the production of various types of thin plate. Large continuous and semicontinuous strip mills have been built. During the same period, however, only a relatively small number of heavy-section, medium-section and wire-rod mills have been built and not a single rail or large structural-section mill has been erected. Therefore, the American plate-rolling mills are, as a rule, technically more advanced than rail and structural section mills.

Specialization and cooperation in the manufacture of steel mills in the USA made it possible to reduce production costs substantially, to provide equipment of high quality and to reduce delivery time (any steel rolling mill in the USA can be supplied in under two years).

The Conference noted that in spite of the high level of rolled plate production achieved, we still do not meet the need of the national economy and we delay the development of some branches of industry. The production of cold-rolled steel plate (especially electrotechnical, stainless steel and tin plate) is inadequate. There is no production at all of thick plate of suitable dimensions for large-diameter pipes.

Extensive discussion developed on the question of the desirability of building, in the USSR, hot-rolling strip mills with coilers in the furnaces.

B. S. Shapiro (State Planning Commission of the Russian Federal SSR) and V. G. Ledkov (The "Zaporozhstal' " Works) were against the introduction of such mills as they maintained that they are uneconomical, have low output and do not ensure a high quality of thin steel sheet.

F. A. Ksenzuk (the "Zaporozhstal'" Works) considered that the production of transformer steel can be set up at continuous and semicontinuous mills; stainless steel, however, judging from the experience of the "Zaporozhstal' " Works is difficult to roll on modern continuous mills. Some serious steps must be taken to eliminate the defects in the rolled product from the Novolipetsk Works, and only then should one decide if the strip mills with coilers in the furnaces should be built at other works.

V. V. Borovskii and L. L. Solov'ev (the "Zaporoshstal' " Works were of the opinion that it is not desirable to roll stainless steel on the continuous mill since the mill and its auxiliary equipment were not designed for this type of service.

G. M. Pavlovskii (the Komintern Works), N. R. Smolyakov (the Novomoskovskii Works) and some others pointed out that the Works which manufacture thin sheets, tin plate and other products in packets were not adequately dealt with in the papers presented to the Conference. The problems connected with the modernization of these works must receive serious attention.

Comrade L'vov (the Kiev Polytechnical Institute) stressed that the tower-type furnaces for the heat treatment of thin strip proposed by the Stal'proekt and based on operating experience abroad are very cumbersome and unreliable in operation. He had developed a rapid laboratory method of recrystallization which would permit the design of a new-type better furnace; it is now necessary to build a pilot plant.

Well deserved reproaches were addressed to design organizations and machine-building works which do not always pay enough attention to the operation of plants which they have designed and built and, therefore, old mistakes are repeated in new designs. For instance, a 2800 mm mill similar to the one in operation at the Alchevsk Metallurgical Works is being installed at the Orsk-Khalilovsk Combine (Comrade Sarkasyan's contribution to discussion). The mill has several shortcomings: it has steel rolls instead of cast iron rolls in the four-high stand, its cutting equipment is inefficient, etc. All these shortcomings have not been eliminated in the mill which is now being installed.

In the discussion special attention was paid to the quality of cast-iron and steel rolls.

A. E. Krivosheev (the Dnepropetrovsk Metallurgical Works) mentioned the inadequate equipment of roll casting plants. It is essential to continue work on the accurate establishment of the chemical composition and hardness of the working and back-up rolls at continuous thin-strip mills. In addition, GOST (National Soviet Standard) for steel rolls of cold-rolling mills should be revised with the object of establishing objective criteria for the quality of these rolls. The plate mill operators want a great deal from automation engineers. The rolling mills and their auxiliary equipment are not yet adequately mechanized and automated. It is necessary to introduce an automatic measurement of

the sheet thickness during the flow of material at the continuous sheet mill as soon as possible.

The Conference passed a detailed resolution.

An important task in rolled-plate production is the modernization of existing equipment on the basis of an integrated mechanization and automation of all operations with the use of computers, as well as a further improvement of the rolling process.

It is planned that several large-capacity thick-plate two-stand mills with four-high finishing stands, including a mill with rolls of 4000-4500 mm long barrel, for the production of thick plate should be built during the current seven-year period. Taking into account the importance of the heat treatment of thick plate, one must provide, in new designs, as well as during the modernization of the mill for the installation of special heating facilities; no mill should be started without these facilities. The Conference recommended that metallurgical factories should make use of the successful techniques of the Kuznetsk Metallurgical Combine and the Stalino Factory regarding the removal of scale at thick plate mills by steam-blasting with the use of special rolls with indented surface. It is recommended that more use should be made of flame scarfing for slab dressing.

As regards the production of thin steel sheet the Conference recommended that in new designs special attention should be paid to automatic control of the optimum speed of entry, the tension of the strip between the stands and the control of the strip thickness; the weight of the coils should be increased and in this connection the process of welding the coils at the pickling machines should be developed. The Conference submitted to the State Planning Commission a proposal that the production of large-capacity self-loaders for ground transport should be started.

It is recommended not to start continuous thin-sheet mills with high speed of rolling without the necessary instrumentation for automatic quality control.

It is recommended that four-stand mills should be installed at cold-rolling shops since these mills can be used for rolling a wider variety of plate than three-stand mills. The use of coiling in the production of cold rolled plate constitutes an advance in rolling techniques since it permits an increase in productivity and an improvement in the quality of the product. The change to this method of rolling at the cold rolling shops of the "Zaporozhstal' " Works and the Magnitogorsk Metallurgical Combine should be speeded up.

It was proposed that the scientific and research institutes should develop new methods of scale removal from strip by using ultrasonics, new reagents, electrolytic pickling of high-alloy steels and other alloys, and new methods of pickling, solution regeneration, etc.

In tin plate production, our country is much behind other technically advanced countries. Most of the tin plate produced in the USSR is made from hot-rolled sheets which are subsequently hot-dip tinned and this involves a high consumption of tin. Electrolytic tin plate constitutes only about 5% of the total tin plate production of the USSR.

The Conference considered it necessary to put modern mechanized tin plate shops into operation at the "Zaporozhstal' " Works, the Magnitogorsk Metallurgical Combine (the second priority shop) and the Karaganda Works. Continuous heat treatment methods in tower furnaces and electrolytic tin-plating machines using acid electrolytes should be more extensively introduced in new shops. The development of new, high-capacity units for continuous hot-dip tinning must be speeded up.

In order to increase the production of transformed dynamo sheet and strip steel, the Conference found it necessary to ask the Novosibirsk National Economic Council and the Novosibirsk Metallurgical Works to speed up the introduction of a continuous furnace for the heat treatment of transformer steel, to complete the construction of the cold-rolling shop of the Novolipetsk Works in 1960 and in particular to speed up the installation of the equipment which comprises the second phase of construction and includes the production of coiled transformer strip equivalent in its electrotechnical properties to the best foreign products, to speed up the decision on the modernization of the Verkh-Isetsk Metallurgical Works and finally to design and build a machine for welding transformer steel in the argon atmosphere at the Novolipetsk Works. It is essential that work on the introduction of automatic sorting of transformer steel sheets according to their electromagnetic properties should be continued. It was proposed that the TsNIIChM should establish the thermal treatment regime for cold-rolled dynamo steel sheets in continuous instead of bell-type furnaces and also a method for the production of these sheets in a one-stage cold-rolling process.

As regards the design and operation of reheating pit furnaces one should introduce apart from bottom-fired furnaces furnaces of other types, in particular, pit furnaces fired with one top burner. Work on a further improvement of slag removal in the liquid form should be continued.

As the normal design for modern continuous furnaces, one should take the multizonal furnaces with four or five lines of burners with their flame direction opposite to the movement of the metal; an extensive use of natural gas of high calorific values is recommended for furnace firing.

In the field of thin-sheet production the Conference recommended an extensive introduction of units for the continuous heat treatment of strip; tower-type furnaces should be used in new large tin plate shops, and horizontal uniflow or rotary furnaces in small shops. The use of bell furnaces should be limited.

With the object of reducing the build-up of metal, scratches and indentations on cold-rolling rolls, one should increase the weight of ingots and hot-rolled coils as much as possible, improve the pickling of the strip before the rolling by applying cascade pickling and establish the permissible service life of rolls between roll changes depending on the operation regime of the rolls. In the design of plate rolling mills, provision should be made for a normal utilization of rolls (space for storage, repairs, etc.).

The mechanization and automation of rolled steel production received thorough consideration in the resolutions of the Conference. Only extensively mechanized and automated mills should be accepted from manufacturers. Special attention should be paid to finishing, sorting and packing the sheets since these are the most labor-consuming operations.

The Conference was well organized. The participants had the opportunity to see the "Zaporozhstal'", "Dneprospetsstal'" and Voroshilov Works as well as to visit the V. I. Lenin Dneproges (Dnieper Hydroelectric Station).

RATIONAL SCHEMES FOR COLD DRAWING AND ROLLING OF TUBES

M. A. Freiberg

Deputy Head of the Tube Drawing Shop of the Pervoural Novotrubnoi Works

In recent years new schemes, which involve the elimination of one or even two passes, for the cold drawing and rolling of tubes at the drawing shops of our Works have been revised, streamlined and adopted. Thus, for instance, 10 x 1 mm tubes from steel 10-20 were previously made from 57 × 3.5 mm tube billets in nine passes with 1.66 draft with the pass arrangement shown in Table 1.

With the adoption of parkerizing and the use of mandrels made of hard VK-8 alloy, the scheme of rolling 10 × 1 mm tubes was revised, and now, according to the new scheme, tubes of this size are made in eight passes with a draft equal to 1.8 (Table 1). If the tubes are made by a combination method, which involves cold rolling and cold drawing, two more passes can be eliminated (Table 1). Under these conditions, if the tubes are to conform to GOST and not TU 1078, the rolled pieces are reduced to 25 x 0.85 mm on the KhPT-1 $1/2$ inch mill, and the subsequent drawing is carried out without mandrels; this simplifies the preparation of the tubes in the pickling section. In this way, the process of making 10 × 1 mm tubes has been reduced from nine passes to six.

TABLE 1. Pass Arrangements for Drawing 10 x 1 mm Tubes

Pass No.	Old, mm	New, mm	Combination mm
0	57×3.5	57×3.5	57×4.0
1	51×2.5*	46×2.5*	38×3.3 (mill KhPT-2½")
2	46×1.75*	40×1.6	25×1.05 (mill KhPt-1½")
3	40×1.3*	34×1.2	20×0.9*
4	34×1.1*	30×0.85**	16×0.95***
5	30×0.85**	22×0.9***	12×0.98
6	22×0.9***	16×0.95***	10×1.0
7	16×0.95***	12×0.98***	
8	12×0.98***	10×1.0	
9	10×1.0		

* Drawing with a short mandrel, annealing
** Wall preparation; lubricated
*** Drawing without the mandrel

Tubes 25 × 1 mm from 57 × 3.5 tube billets of steel 10-20 were made according to the scheme shown in Table 2.

The use of hard-alloy mandrels permitted the elimination of one pass. In conjunction with one rolling operation on the KhPT-2½" mill, yet another pass was eliminated and the tubes were made in four passes (Table 2). If the tubes are made to conform to GOST and not to TU 1078, twomore passes can be eliminated from the scheme. When the dimensions of the initial tube billet were modified in connection with a new design of the drawing equipment (design by the Moscow Steel Institute), the tubes were made in a single pass. In this design the draft coefficient is equal to 7 and the deformation is 85% (see Table 2).

25 x 1.5 mm tubes from steel 10-20 have been made for a long time according to the scheme shown in Table 3. If mill KhPT-2 $1/2$ is used, the tubes can be made in two passes. If this scheme (Table 3) the main deformation takes place at mill KhPT (draft in the first pass =4.3), and the tubes are drawn without mandrel to their final dimensions with a draft of 1.25. The same tubes are made in one pass from 46× 4.0 mm billet on mill KhPT-1½" of the UZTM.

During the revision of the drawing schemes for several tube sizes it was possible to employ the drawing of lubricated tubes so that the cycle of operations was again reduced since the thermal treatment and pickling operations were eliminated.

For making 29 x 2.5 mm sea tubes in conformity with GOST 1060-53, the scheme included four passes with the use of short mandrels. By increasing the deformation in the first two passes it was possible to have the fourth pass without the mandrel and to eliminate the annealing operation in the third pass so that the length of the cycle was again reduced. When the initial size of the billets was modified, one more pass was eliminated, and

TABLE 2. Pass Arrangements for Drawing 25 × 1 mm Tubes.

Pass No.	Old,mm	New,mm	With one rolling operation on the KhPt-2½" mill (mm)	According to GOST, mm	In conjunction with the new design of the equipment
0	57×3.5	57×3.5	57×3.5	57×4.0	46×4
1	51×2.5*	46×2.5*	38×1.3 (mill KhPT-2½")	38×3.1 (mill KhPT-2½")	25×1 (mill KhPT-1½")
2	46×1.75*	40×1.6*	34×1.1*	25×1.0 (mill KhPT-1½")	—
3	40×1.3*	34×1.2*	30×0.95**	—	—
4	34×1.1	30×0.85**	25×1.0	—	—
5	30×0.85**	25×1.0	—	—	—
6	25×1.0	—	—	—	—

* Drawing with a short mandrel

** Preparation of the wall

TABLE 3. Pass Arrangements for Drawing 25 × 1.5 mm Tubes

Pass No.	Old, mm	New, mm
0	57×3.5	57×3.5
1	51×2.55*	32×1.4 (mill KhPT-2½")***
2	48×1.85*	25×1.5
3	38×1.6*	
4	30×1.4**	
5	25×1.5	

* Drawing with a short mandrel

** Preparation of the wall; lubricated

*** Annealing

TABLE 4. Schemes of Drawing 25 × 3.5 mm and 26.4 × 4 mm Tubes

Pass No.	Tube size, mm			
	Tubes 25×3.5			
	Case I	Case II	Case III	Case IV
0	57×3.5	57×3.5	57×3.5	57×3.5
1	48×3.2***	46×3.2**	46×3.2*	38×3.3*
2	38×3.3*	38×3.3*	32×3.35*	25×3.5
3	30×3.4*	30×3.4*	25×3.5	
4	25×3.5	25×3.5		
	Tubes 26.4×4.0			
0	57×4	57×4	57×4	
1	48×3.6**	46×3.7*	38×3.8*	
2	40×3.8*	32×3.9*	26.4×4	
3	30×3.9*	26.4×4		
4	26,4×4			

* Annealing

** Lubricated

*** Wall preparation

when mill KhPT came into use the tubes were made in two passes.

Mastering these drawing schemes contributes to the flexibility of operation so that depending on the available tube billets and the free time of the KhPT-2½" mills, the schemes which are most suitable at a given moment can be utilized.

Table 4 shows the schemes for making tubes 25 × 3.5 mm and 26.4 × 4 mm from steel 10-20 and 20. In the new schemes, the draft was increased from 1.34 to 1.62; at the same time, normal stresses in the drawn part of the tube in the first pass reached 62 kg/mm² which is close to the ultimate tensile strength of work-hardened steel 20 (78-80 kg/mm²). It was possible to adopt these schemes because there was a large reduction of the diameter from 57 to 38 mm, i.e., by 19-20 mm in the first pass with a mandrel.

Drawing schemes involving a 15 mm reduction in diameter with the use of a mandrel were employed for steels of high resistance to deformation. Thus, 30 × 5 mm tubes from steel 35 which were previously made in three passes are now made in two passes. Tubes 42 × 5 mm from steel 36G25 previously made in two passes are now made in one. Tubes from steels 12KhMF, and some others are also made in a smaller number of passes.

The characteristic features of the above schemes are:

1. During the production of tubes of 1-2 mm wall thickness, the largest part of the deformation is effected on the KhPT mills.

2. In the last passes the tubes which conform to TU 1078 are drawn with and without a mandrel and, hence, a better surface and more accurate dimensions are obtained.

3. Tubes of 2.5-4 mm wall thickness from 57 mm tube billet are reduced in diameter by 19 mm in the first pass with a mandrel, i.e., the diameter is reduced to 38 mm.

4. In the production of tubes of 5 mm wall thickness, the diameter is reduced by 15 mm in the first pass with a mandrel.

To achieve such extensive reductions we introduced mandrels made of hard VK-8 alloy and mandrels with threaded mandrel rods, because inserted mandrels could not stand the high radial pressure created in the center of the deformation and used to fracture.

The adoption of the rational schemes for drawing and rolling tubes made it possible to increase the overall output by 5%, and, in the case of some tubes which were difficult to make, by 20% or more without any additional equipment.

V. L. Ozol'. Experience on the Automation of a Tube Rolling Mill. Metallurgizdat, Khar'kov, 1959, 79 kp.

The booklet contains an account of the experience on the automation of tube rolling machine 140 at the Lenin Works. The analysis of the operation of individual mechanisms and their conversion to an automatic control system are presented.

An account is given of pneumatic drives and distributors, special instrumentation for the automation of the plant—indicators of the position of the rolled piece at various mechanisms of the machine, tensometric relays and time relays. The automatic delivery of the billets from the furnace with a rolling speed controller, the control of equipment for aligning the hot billet, the control of the pusher which pushes the billet into the piercing mill, the operation of the piercing mill delivery equipment as well as the control of the automatic mill, sizing machines and coolers, are discussed.

The basic principles of the design, installation and maintenance of automatic control equipment and also experience in its operation are described.

The booklet is intended for technical personnel engaged on the design, installation and operation of tube rolling mills.

RELIABLE OPERATION OF OVERHEAD CRANES

The regular operation of a shop depends to a large extent on the reliable operation of its overhead electric cranes. However, the crane bridges are still unsatisfactory in operation: girders tend to get out of alignment, the wheels jam, their flanges become flattened out and damage the rail heads by forming step-like impressions (Fig. 1). As a result, there have been cases when the crane came off the crane runway and so the wheels and the runway rails had to be frequently repaired or replaced. The "Zaporozhstal'" Works uses 1000-1100 wheels (300-330 t) and about 400 t of rails per annum as replacements.

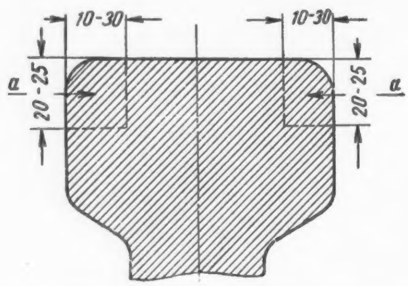


Fig. 1. Step-like impressions(a) in rail heads.

The misalignments are caused by the narrowing of the bridge base and the inadequate rigidity of the girders; the flattening out of the wheel flanges results from the misalignment of the bridge girders and insufficient spaces between the rail head and the flanges of the wheel; the formation of impressions on the rail heads is due to too low wheel flanges (dimensions according to GOST 3569-47).

For a reliable operation of the cranes it is necessary:

1. To make the transverse beams 800 mm longer and to make the joints between the longitudinal and transverse beams more rigid by putting more gusset plates on the corners with the object of preventing the misalignment of the girders.

2. To make the distance between the rail head and the wheel flanges greater (on an ordinary wheel the distance should be increased to 50 mm, and on tong cranes and stripping and casting cranes to 60 mm).

3. To increase the height of the wheel flanges to 40 mm or to make them the same height as the rail heads.

4. To replace wheels with ordinary tread, when worn out, by wheels with self-centering tread (Fig. 2), on cranes where wheels with wider tread can be accommodated. These wheels can be adopted without any changes in other parts of the crane and establish favorable conditions for the roller bearings since the running elements will not tend to be extended or contracted by a widened or narrowed crane runway as happens with an ordinary wheel tread.

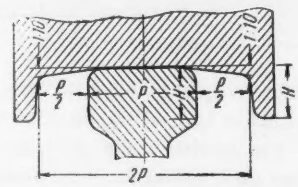


Fig. 2. Wheel with self-centering tread.

All these measures will permit the cranes to operate at an higher speed.

The wheels cast from steel 65G with surface-hardened treads did not justify themselves. The depth of hardening of the tread did not exceed 1-2.5 mm and the hardness did not exceed 290-350 H_B.

These wheels become useless on heavy duty cranes after 3 or 4 months of operation; the hardened surface of the tread crumbles away, the flanges bend out and break off. Therefore, the manufacture of wheels by the old method should be discontinued.

The crane track wheels should be rolled or forged from steel U8 and should subsequently be sorbitized. Wheels made in this way will work for 9-10 years.

Until the new method is developed, wheels should be cast from steel 65G or 50G2 and their tread should then be sorbitized.

The method of making wheels from these steels at our Works is as follows. After the removal of risers and gates by a gas flame, the castings are hardened up to 229 H_B hardness number and are then machined. All the parts of the wheel except the holes and the hub are machined down to the design dimensions. The holes and hubs are first subjected to a preliminary machining with tolerance up to 4 mm and then after the sorbitization they are machined to their final dimensions.

The method of sorbitization is as follows: after they are heated to 800°C, the wheels are mounted on a ro-

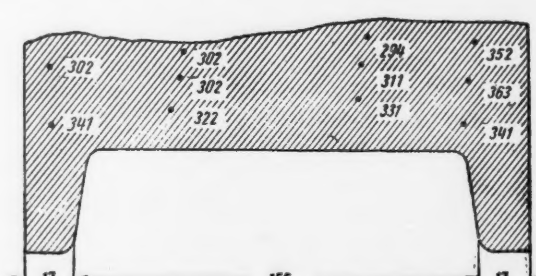


Fig. 3. Hardness at various points of the tread after the sorbitization of the wheel (the figure at each point denotes the hardness number, H_B).

tating mechanism in the water bath and are rotated for three minutes at a speed of 75 rpm. The running water in the bath should cover the whole height of the rim. The temperature of the water is 18-50° C.

The results of the study of samples confirm that this way of strengthening fully ensures the required properties of the wheel tread (Fig. 3).

The problem of selecting a steel for the wheels is still controversial. The "Zaporozhstal' " Works favors steel 65G, but the Kuznetsk Combine and some other works prefer steel 50G2. To settle this controversy, the "Zaporozhstal' " Works has made two batches of wheels, one batch from each steel, and are keeping them under observation. So far, no difference has been observed between the two batches of wheels in service.

Since for repairs to the crane runway one has to switch off the whole bay, the condition of the runway remains often unsatisfactory.

To ensure suitable conditions for successful repairs to runways, one should divide the trolleys in old shops into groups with sections of 30-60 m and carry out repairs to the runways at the same time as to the cranes and according to the schedule.

A better design, however, is one with trolleys suspended from the column superstructure of the crane beam columns above head height. Therefore, whenever possible, one should change to this design of suspension at old shops and it should be strongly recommended to incorporate it in the design of new bays and shops. Also, it is desirable to discontinue using direct current for cranes; this will make the construction simpler and cheaper.

THE VISIT OF CZECHOSLOVAKIAN METALLURGISTS TO THE SOVIET UNION

V. A. Podzerko

Chairman of the Central Committee of the Metallurgical Workers Trade Union

Friendly relations between Soviet and Czechoslovakian metallurgists have long existed. The Trade Union Committees of several Soviet metallurgical establishments maintain contact with the trade union organizations of similar Czechoslovakian establishments; they keep up correspondence, arrange exchange visits of delegations, and study together their experiences in trade-union and production work.

Last year, a delegation of Soviet metallurgists from the Dzerzhinskii Works acquainted themselves with the living conditions and work of Czechoslovakian metallurgists. "We were welcomed as real friends in Czechoslovakia and were given every opportunity to study thoroughly and in detail the industrial experience of Czechoslovakian metallurgists," said the members of the Soviet delegation on their return home.

Recently, a delegation from the K. Gotwald Metallurgical Works in Vitkovice and from the October Revolution Works in Trzynec paid a return visit to the Soviet Union.

The delegation was made up of people from various walks of life; it included a leader of a team of steel melters, a deputy director of a tube mill, a fitter, and a Party official. The delegation was led by Yaromir Mrkva, the Secretary of the Ostrave District Committee of the Metallurgists Trade Union. The guests visited Moscow, Leningrad, Dnepropetovsk and Dneprodzerzhinsk.

In Moscow, the guests saw places of interest; they visited the Mausoleum of Lenin and Stalin, the Kremlin and the Armory. They also went to the ballet "Swan Lake" at the Stanislavskii and Nemirovich-Danchenko theater. Our Czechoslovakian comrades were full of admiration for what they saw.

The delegation was present at the Parade and Workers' Rally in Red Square. This magnificent spectacle made an unforgettable impression on them.

The delegation spent two days in Leningrad. In this city—the cradle of the October Revolution—the Czechoslovakian metallurgists visited historic places connected with V. I. Lenin, the cruiser "Avrora", the Hermitage, the Petropavlovsk Fortress, Isaak Cathedral and other famous places.

"I am glad—said one of the visitors, Comrade Novak—that I was fortunate enough to see places connected with V.I. Lenin. Now, I shall be in a position to describe these places to Communists at home as an eye-witness and not from what I have read in literature."

In Dnepropetrovsk, the delegation visited the Karl Liebknecht Works, saw the Shevchenko Park and went sightseeing in the town. The guests spent most of their time in Dneprodzerzhinsk. They acquainted themselves here in detail with the trade-union and production work of the personnel at the Dzerzhinskii Metallurgical Works as well as with the way of life, the social conditions and the leisure of Soviet metallurgists.

The delegates studied most thoroughly the work of the blast-furnace shop, open-hearth shop and new rolling shop. The operation of one of the blast-furnaces attracted the attention of the visitors. They noted the orderliness at the working places and the successes in the field of automation and mechanization.

In the open-hearth shop, the visitors studied the work of the steel melters, observed the charging melting, and tapping operations and a major overhaul of a furnace. They met and had friendly talks with Chinese specialists who were acquiring industrial experience at the Dzerzhinskii Works. The delegates were present at one of the shift-change meetings. They very much liked the idea of holding these meetings.

The Czechoslovakian metallurgists and the staff workers of the Dzerzhinskii Works discussed their experiences in trade-union and production work. They had talks with management personnel, heads of shops and foremen, and they attended a meeting of the Works Committee, a meeting of the Permanent Production Conference, etc.

The delegates showed interest in the organization of the Socialist competitions, in the work of the Teams of Communist Labor, and in the method of evaluating the results of the Socialist competitions. They asked questions on methods of encouraging good workers and punishing those who violate industrial discipline and do not carry out the resolutions of Production Conferences; on how the Permanent Production Conferences are set up and how they work; and on the work of Party and trade-union groups.

It was the unanimous opinion of the Czechoslovakian metallurgists that they benefitted greatly from the visit to the Dzerzhinskii Works. Comrade Balash expresses it well by saying: "We have learned a lot from you, dear comrades from Dzerzhinsk. The utilization of production capacities of metallurgical plants at your Works and the fight of the personnel for an economic consumption of raw and other materials is an example for us to follow. We shall make every effort to adopt the advanced techniques of the Dzerzhinsk workers at our metallurgical establishment."

During their stay in Dneprodzerzhinsk, the delegates visited several cultural, social, and health institutions of the steel workers. They visited the Works Clinic and Hospital, the kindergarten, a hostel, the shops, and a building site for houses for the workers. They went by boat on the River Dnieper to a pioneer camp, they acquainted themselves with subsidiary operations of the Works, they saw the crops, the settlement, the dam, and the construction of a poultry plant.

The delegates had a meeting with active workers of the Palace of Culture; Comrade Kovalenko who took part in the Civil War and fought with the Czechs in the armored train "Sovietskaya Ukraina" spoke at the meeting. The delegates studied in detail the work of the library, the activities of the Amateur Art Circle, and saw the preview of the film "Dzerzhintsy". The workers present in the theatre gave a warm welcome to their guests from Czechoslovakia. The delegates also met the workers. Over 1200 people were present at that meeting. Some of the personnel of the Works related their impressions of their visit to Czechoslovakia, and the Czechoslovakian delegates told about their stay in the Soviet Union. At the end, a concert was given by the Amateur Art Circle at the Works.

An "Evening of Soviet-Czechoslovak Friendship" at which Comrade Novak, a member of the delegation, spoke, was arranged in the "Dom Kommuny" hostel. After a five-day stay in Dneprodzerzhinsk the delegates left for Moscow.

They told the Central Committee of the Metallurgical Workers Trade Union their impressions of their stay in the Soviet Union, and thanked them for the extremely warm and cordial welcome. "The cordial welcome we have received here has warmed us more than the heat of open-hearth furnaces," said Comrad Chtvertnya. The delegates stressed the remarkable successes achieved by the Soviet people in all fields of human activity.

"For a long time, we have known of the remarkable results achieved by the heroic Soviet people. Now, by seeing the work of the personnel of the Dzerzhinskii Works, we have had an opportunity to convince ourselves once more of the tremendous Soviet successes," said Yaromir Mrkva, the leader of the delegation.

The delegates spoke of the rich experience of Soviet metallurgists which they were going to use after their return home, they noted a very active attitude and participation of the workers in the management, and they spoke of the great value of Permanent Production Conferences, shift-change meetings, and the introduction of the competition for the title "Team of Communist Labor."

Before leaving the Soviet Union, our Czechoslovakian comrades asked us to transmit their best greetings to all Soviet metallurgists and assured us that in the future they would foster an even closer friendship and cooperation between our two nations.

THE UNIVERSITY OF CULTURE FOR IRON AND STEEL WORKERS

The "Metallurgists' University of Culture" established on the initiative of the Party and the Trade Union Committees and based on the M. Dzabarly Palace of Culture at the Azerbaidzhan Tube Rolling Works was officially opened on April 21.

More than 600 metallurgical workers—mill operators, open-hearth workers, pourers, administrative workers, technical personnel, etc.—enrolled in the two divisions (Russian and Azerbaidzhan) of the University of Culture. The syllabus is to be spread over three years (150 hours) and includes lectures, discussions, talks, popular scientific film shows, theatre plays, excursions, record-playing sessions of literature, art, communist education and culture, natural sciences and technology. A substantial part of the syllabus is devoted to the study of the reports of the Twenty-first Congress of the Communist Party of the Soviet Union.

As a rule, the timetable comprises two three-hour sessions a month: a session consists of 1 or 2 hours of lectures and 1 or 2 hours of complementary program (a concert, film show, excursion, etc.). At the end of each year, the students sit for an examination in each subject and after completing a three year course they receive a certificate. There are no fees.

Lecturers from the Azerbaidzhan Society for the Dissemination of Political and Scientific Knowledge, the Party and administrative officials of the Azerbaidzhan Republic and from the town of Sumhait, professors and lecturers from universities and scientific establishments in Baku, composers, actors and artists are invited to give lectures and assist in the work of the University of Culture.

The administration of the University is supervised by an 11-man Council composed of representatives of the works' social organizations, the management of the D. D. Dzhabarly Palace of Culture and others.

The work of the University started with a lecture entitled "The Twenty-first Congress of the CPSU and the communist education of workers" given by G. A. Aliev, the First Secretary of the Communist Party Town Council in Sumhaitsk. The lecture was followed by a concert.

R. S. Yusupov.

EIGHTY YEARS OPERATION AT THE CHUSOVA STEEL PLANT

A. N. Lekontsev

Head of the Metallurgical Laboratory of the Chusova Steel Plant

At the confluence of the Chusova and Us'va Rivers on July 12, 1879, work was started on the construction of the Chusova Steel Plant. The Plant belonged to the Franco-Russian Urals Joint-Stock Company. The first to be built and started was the puddling shop. This took iron from the Pashiisk Plant, which also belonged to the Franco-Russian Company, and made blooms which were processed to billets and roofing tin. In the puddling shop there were 16 furnaces of simple design with a 25 pood* charge. The exit gases were burnt under the steam boilers.

In 1881, a machine was installed to roll blooms to mill bars for the Nytvensk Plant. In 1894, the first blast-furnace was blown and in 1898 the second. Both furnaces were fired by wood charcoal which was transported overland. The ore was brought from the local ore mines and along the Chusova River.

The continuously increasing smelting of iron necessitated the expansion of rolled production. In 1883 a medium grade shop was built (now the 550 mill) to roll mill bars, billets and section iron, in 1894 a light section shop (now the 250 mill) and in 1906 the large section rolling mill was put into operation (now the 650 mill).

The development of the Chusova Plant coincided with a radical change in steelmaking. Puddling production was replaced by the more highly developed and economic open-hearth process for making steel. The owners of the Chusova Plant also had to adopt open-hearth production. In 1897 the puddling furnaces were stopped (two open-hearth furnaces were operating at the plant). In 1907 the building of the open-hearth department was finished.

After the Great October Revolution, the Chusova Plant came under State control. The workers helped to restore the economy of the Urals and Siberia, especially rail transport. Bridges which had been extensively damaged or destroyed were restored by the factory workers.

The plant developed rapidly in the years of the first 5-Year Plans. During this time, production was started on spring strip for the tractor industry. In 1930 the Central Committee of the Communist Party decided to redesign the plant, converting it to a plant for high-grade steels and rolled production.

In the redesigning, the whole of the planning and disposition of the rail system was altered, the blast furnace and open-hearth furnaces were rebuilt, a blast furnace was built, together with a mechanized ore yard with a gantry grab crane, new cogging and spring rolling shops.

In 1935 the plant adopted the complex conversion of Urals titanium-magnetite ores with the production of a new Soviet ferroalloy. This again necessitated redesigning of the plant which was continued throughout the period of the Fatherland War.

In 1943 a new modern mechanized blast furnace was started and in 1944 the Bessemer section of a duplex shop was started. During the war years, work was completed on a mechanized charge yard for the open-hearth department, ingot stores, billets and finished production of the old rolling mills; the open-cut limestone mine "Belyi Kamen' " was redesigned. In 1946 the construction of the whole of the duplex shop was finished. The complex conversion of titanium-magnetite ores was therefore adopted.

The present day Chusova Plant bears little resemblance to the pre-Revolution plant. The length of railway lines has increased by 20-fold; whereas previously there was one locomotive, there are now 50 at the plant. The production of metal has been increased many times.

* A pood is 36 pounds – Publisher's note.

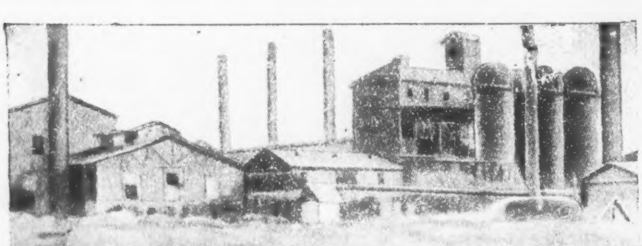


Fig. 1. The Chusova Plant blast furnace before the revolution.

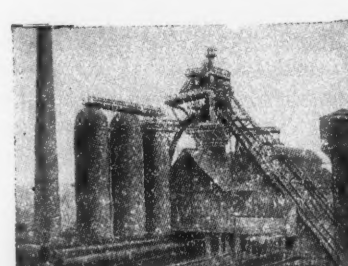


Fig. 2. The present-day blast furnace

At the present time the plant works on the following system.

A sinter consisting of Kusinsk ore concentrate, graded Pervourals ore, local sinter of blast furnace dust, screenings of Pervourals ore and waste from the chemical industry is smelted in blast furnaces, giving a special iron with the following composition %:

Si	Mn	Cr
0.4—0.5	0.2	0.5—0.6
Ti	S	P
0.2—0.3	До 0.06	0.08—0.09

The iron is blown in a converter with a magnesite lining, a special slag being obtained—raw material for the ferroalloy industry and a semifinished product of the following composition, %:

C	Si	Mn
3.1	traces	traces
Cr	Ti	P
0.06 — 0.1	traces	0.09 — 0.11

From the semifinished product killed and rimming steels of various grades are obtained. Ingots weighing 1550-1700 kg are rolled on a cogging mill to billets of 95 x 95 mm section and greater, from which spring strip, automobile rims and other profiles are obtained on spring, small and medium section mills. A part of the rimming steel is cast in steel ingots weighing about 500 kg, from which sheet is rolled.

In the postwar years and particularly in the period between the Twentieth and the Twentieth-first Conferences of the Communist Party of the Soviet Union, the Chusova engineers have found new ways for increasing the output of existing shops and units.

In the blast furnace shop the proportion of sinter in the charge has been increased to 80%, the blast has been automated and the operation changed to constant humidity blasting. This has caused a sharp drop in the coke consumption, has reduced the amount of slag and increased the extraction of the main alloying element of the iron. In the duplex shop, special iron is blown in converters with a magnesite lining. Changing over the open-hearth furnaces to oil firing has permitted an increase in the charge. In the cogging mill, the speed of rolling ingots of increased weight has been stepped up. By improving the methods, the section mill workers are constantly increasing the output of the units.

Conditions for the workers have also improved along with the development of the plant.

Before the revolution, the factory population was sharply divided into regions: the center with the main road "Bolshoi", where the plant managers, the local Bourgeoisie and the merchants lived and where almost all of the trade was concentrated; the "French Colony" on the bank of the Chusova River with a predominantly French population—the plant foreman; the working quarters—Bol'nichnaya Gora, Dal'nii Vostok, Tatarskii Poselok, Harbin, Novaya Derevnya, Myl'naya, Svyataya (later Mekhanicheskaya) Streets. Dirty unpaved streets, smoky barracks, tiny houses ("Numbers")—such was the settlement.

The town now has many attractive blocks of flats; it also has a water mains, community heating, and the roads are paved with blocks. The slums have been replaced by attractive areas—Bol'nichnaya Gora, the Poselok Metallurgov and blocks of flats with a school and hospital; in the former "French Colony" work has been started on a bridge over the Chusova which will permit the living accommodations to be rapidly developed on the region of the left bank.

The Seven-Year Plan calls for the construction of the Kachkanarsk Ore-Enrichment Combine, which will supply the plants of the Urals, including the Chusova Plant, with high quality sinter. In this connection it has become necessary to redesign the plant, the plans for which are being developed by Uralgipromez. When it has been redesigned, the Chusova Plant will be fully equipped with the newest equipment and will occupy an important place among the industrial plants of our country.

Dear Reader,

We wish to remind you that starting from October 1, 1959, subscriptions can be made for the popular industrial technical journal

METALLURGIST for 1960.

The Twenty-first Congress of the Communist Party of the Soviet Union, set out great tasks for the Soviet people in connection with the extensive building of a Communist society.

The nationwide competition for technical progress and the fulfillment of the Seven-Year Plan ahead of schedule is spreading all over the country. In connection with carrying out the tasks outlined by the Twenty-first Congress and the June session of the CC CPSU, an extensive exchange of experience, the dissemination and adoption of advanced techniques and the discussion of technical advances in ferrous metallurgy have become of great importance.

The "Metallurgist" makes it its object to discuss the problems of the introduction and utilization of new techniques, experience on the mechanization and automation of industrial processes as well as the achievements of home and foreign metallurgists.

In 1960, it is planned to publish papers on complex mechanization and automation in industry, on new devices and plants which are to be put into operation during the current Seven-year period, on saving materials and a reduction in production costs. Through our journal you can obtain authoritative answers on various problems of the metallurgical industry.

In order that the journal can successfully achieve its objective, it is necessary that all metallurgists should actively participate in our work. Please send us your requests, articles, comments on technological improvements, modernization of existing plants, new mechanisms and machines which would facilitate production, on reducing production costs and increasing operating efficiency, etc.

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SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NIIZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us – Publisher.